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CLINCH RIVER BREEDER REACTOR PLANT ENVIRONMENTAL REPORT

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PROJECT MANAGEMENT CORPORATION

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1.0 PURPOSE OF THE PROPOSED FACILITY

1.1 INTRODUCTION

The Clinch River Breeder Reactor Plant (CRBRP) will provide a vital step in the United States' reactor development program. The objective of the U. S. Atomic Energy Commission (USAEC) Liquid Metal Fast Breeder Reactor (LMFBR) program is to develop, on a broad, proven technological and engineering base, with joint utility and industry participation, a cooperative commercial breeder reactor industry.

The development of the LMFBR will provide an additional option among the power generating technologies available to the utility industry before the end of this century. The major incentive for development of breeder reactors is the potential for vastly improved utilization of uranium fuel resources and thus, extension of that natural fuel resource over a considerably longer period of time. This is of particular importance during these times of recognition of the dwindling of our energy resource base. The CRBRP is essential to the timely development of this option which can enable the responsible use of natural energy resources and provide economic benefits at the same time.

As suggested by Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Plants," Section 1 of the Environmental Report should generally discuss the need for the proposed facility. The suggested format and content for Section 1, however, are directed primarily toward nuclear power plants built for the specific purpose of generating electrical power, and hence are not strictly applicable to the CRBRP. The primary purpose of this project is broader in scope, with the basic objectives being those outlined in Section 1.1.2. Thus the justification for this project is based primarily on its technological nature and the contribution that the proposed project will make toward the achievement of the timely availability of the LMFBR as a power generation technology option for commercial use. The electrical power generated will be incidental to the primary objective.

The CRBRP will be operated as an integral part of the Tennessee Valley Authority (TVA) electrical grid, but its additional generating capacity will not be used in TVA's plans to install capacity to meet future system load demands. The total net electrical output of the CRBRP during the demonstration period will be purchased by TVA at the highest incremental cost TVA would have incurred at generating plants on its system which it would otherwise have used for producing the same amount of energy or which it would have incurred in acquiring such energy from other sources through interchange and/or purchase. It has been estimated that this will amount to a total revenue to the Project of approximately $47 million in 1974 dollars over the demonstration period.

As stated in the recently issued Draft Environmental Impact Statement for the LMFBR Program,(1) major emphasis is being placed on the development of a technology that will lead to an economic, reliable and safe source of nuclear energy which will breed fissionable material so as to reduce the uranium and separative work requirements for the remainder of this century. Within the context of the overall LMFBR program, the CRBRP is an essential step toward achievement of the program objectives. In turn, achievement of the program objectives would provide the Nation with the option of employing LMFBR technology for power generation on a broad, commercial scale.

1.1.1 BACKGROUND

The CRBRP, as part of the AEC's "Cooperative Power Reactor Demonstration Program" announced in January, 1972, commenced with acceptance of the joint Commonwealth Edison Company of Chicago and TVA proposal to work with the AEC to design, develop, construct and operate the first LMFBR demonstration plant. To implement this proposal, two non-profit organizations, Breeder Reactor Corporation (BRC) and Project Management Corporation (PMC), were established to coordinate utility participation, with PMC providing centralized management of the CRBRP through the completion of the five-year demonstration program. In November of 1972, the selection of Westinghouse Electric Corporation was announced by AEC/PMC as the lead supplier of the Nuclear Steam Supply System. The General Electric Company and Atomics International (Division of Rockwell International Corporation), who also submitted proposals for the Nuclear Steam Supply System, were authorized to be retained by Westinghouse Electric Corporation as major subcontractors to the design of the Nuclear Steam Supply System. Burns and Roe, Incorporated, was retained by PMC in December of 1972 as the project Architect-Engineer.

1.1.2 GENERAL OBJECTIVES

In keeping with the objective of the LMFBR program, the objectives of the CRBRP, as stated in Contract No. AI (49-18)-12 among the Project participants are as follows:

1. To confirm and demonstrate the potential value and environmental desirability of the LMFBR concept as a practical and economic future option for generating electrical power;
2. To confirm the value of this concept for conserving important nonrenewable national resources;
3. To develop, for the benefit of government, industry and the public, important technological and economic data;
4. To provide a broad base of experience and information important for commercial and industrial application of the LMFBR concept; and

5. To verify certain key characteristics and capabilities of LMFBR plants for operation on utility systems such as licensability and safety, operability, reliability, availability, maintainability, flexibility and prospect for economy.

The ability of the CRBRP to meet these objectives will provide a firm basis from which the long term goals of the LMFBR program can be attained over the long term. Establishment of an equilibrium breeder reactor economy would both provide the fissile material needed to fuel nuclear power plants and to meet the nation's growing electrical power demand.

1.2 NEED FOR THE LMFBR PROGRAM

In his June 4, 1971, Energy Message to Congress, the President identified the Liquid Metal Fast Breeder Reactor as one of several promising clean energy development areas which should be quickly demonstrated on a commercial scale and announced a commitment "... to complete the successful demonstration of the liquid metal fast breeder reactor by 1980." Underlying this commitment is the expectation that timely introduction of the LMFBR should enable substantial future benefits, in terms of reduced electrical generation and environmental costs, to accrue. The LMFBR will thereby extend available uranium fuel resources from a few decades to centuries and will reduce the requirements for raw uranium ore compared to current nuclear power plant options. The basic need for vigorous pursuit of the LMFBR program has been the subject of exhaustive review through the Atomic Energy Commission's recently issued "Draft Environmental Statement - Liquid Metal Fast Breeder Reactor Program".[1] The Statement provides the starting points from which assessment of the need for, objectives of and importance of timely completion of the CRBRP must follow. Therefore, in subsequent portions of this section, pertinent conclusions of the Program Statement are summarized to provide an appropriate context for consideration of the specific purposes of the CRBRP.

1.2.1 ADVANTAGES OF THE BREEDER

The rapid growth of commercial Light Water Nuclear Reactors coming into operation over the past decade has clearly demonstrated that nuclear energy from Light Water Reactors (LWR's) is an economically competitive, reliable and safe source of energy production. However, the LWR's and gas cooled reactors do not fully utilize the energy potential of nuclear fuel, utilizing only one to two percent of the energy available. Furthermore, a LWR must utilize uranium enriched to approximately three percent in U-235 (in naturally occurring uranium, only 0.7% is the thermally fissionable isotope U-235, the rest being the U-238), an expensive and complicated process resulting in "wasted" U-238 depleted in U-235.

Inefficient use of uranium in Light Water Nuclear Reactors leads to the prediction that the estimated low cost uranium reserves in the United States would be consumed within the next 25 to 50 years using the present light water reactor concept. A more detailed account of these predictions can be found in the references listed in Section 2.1 of the "Draft Environmental Statement, Liquid Metal Fast Breeder Reactor Program".

Because the Breeder Reactor converts non-fissionable U-238 to fissionable Pu-239, the otherwise wasted U-238 is transformed to a useful fuel. More Pu-239 is produced than consumed; hence the term "breeder". This fact of breeding enables the reactor to replenish its own fuel needs and eventually provide enough additional Pu-239 to operate another reactor. The same conversion of U-238 to Pu-239 takes place in Light Water Reactors but only a fraction ($\sim$0.6) atoms of Pu-239 are produced for each fissionable atom consumed. Hence, Light Water Reactors are called "converters" and must be refueled with fuel from other sources.

In the following sections, specific advantages of the Breeder Reactor with respect to thermal conversion efficiency, environmental protection and the liquid metal option will be addressed.

1.2.1.1 EFFICIENCY OF ENERGY RESOURCE USE

As pointed out above, the energy conversion process in LWR's is inefficient in that only approximately one to two percent of the available energy is utilized. The Breeder Reactor, however, by converting the non-fissionable U-238 to the fissionable Pu-239 increases this utilization to potentially over 60 percent.

LWR's, because of their fuel utilization, are also very sensitive to the price of uranium. Hence, as high grade uranium ores become less abundant due to increasing demand by LWR's, the additional processing required for low-grade ores will increase the price of LWR fuel. With the introduction of the breeder comes the ability to economically use not only low-grade ores (which can only be used in LWR's if considerably higher power costs are acceptable) but also the depleted uranium produced as a by-product of the LWR fuel cycle.

A measure of efficiency of the breeding nature of the LMFBR is either the breeding ratio or the compound doubling time. The breeding ratio is defined as the rate of production of fissile isotopes to the rate of destruction of fissile isotopes. A breeding ratio greater than one means that more fuel is being produced than consumed. The compound doubling time is the length of time required to produce as much fissionable material as the amount originally contained in the core plus the amount tied up in the fuel recycling process. As shown in Figure 1.2-1, the compound doubling time of the CRBRP is presently estimated at approximately 30 years.

Once data from ongoing development programs and operational experience are obtained to provide better characterization of the core, this doubling time should be reduced significantly. Present designs for the initial commercial LMFBR's call for compound doubling times of approximately 30 years. Further improvements to the oxide fuels used for these early LMFBR's should reduce the compound doubling time to 10 years. Use of advanced fuels, such as carbides or nitrides (of which development programs are presently underway) are expected to produce compound doubling times of less than 10 years.

1.2.1.2 PLANT EFFECTIVENESS IN THERMAL CONVERSION

The LMFBR, because of the high coolant operating temperatures, has a thermal efficiency higher than LWR's. Thermal efficiency is defined as that fraction of the total thermal power produced that is converted to electrical power.

For a system in which steam is used as the working fluid to drive a turbine, the amount of energy that can be extracted from the steam is generally a function of the magnitude of the steam temperature decrease that can be obtained as the steam passes through the turbine. Since the turbine systems for both LMFBR's and LWR's reject exhaust steam at approximately the same temperature, it follows that the higher LMFBR turbine inlet steam temperature yields more efficient conversion to electricity. For both the LMFBR and LWR, the maximum temperature of the steam entering the turbine is set by the maximum coolant temperature that can be obtained as the coolant passes through the reactor.

In the case of the LWR, the maximum coolant temperature that can be achieved is set by the system pressure which in turn fixes the boiling point. Hence, once the water coolant temperature reaches the boiling point, no further temperature increase can take place. For Light Water Reactors, this temperature is fixed usually between 500 degrees F and 650 degrees F. Steam superheating in the LWR core has not proved practicable due to fuel cracking problems. Any further increase of the steam temperature would then have to be accomplished by non-nuclear means, such as oil-fired superheaters. Also, because of the low steam temperatures in LWR's, steam reheat is not economically advantageous. For these reasons, thermal efficiencies for operating LWR's are usually between 30 to 33 percent.

The LMFBR, because of the high boiling point of sodium (approximately 1,650° F), can achieve high core outlet temperatures and is not limited by the boiling phenomena associated with LWR's. As a consequence, relatively high steam temperatures can be obtained since the sodium temperatures are well above the water boiling point at design pressures and direct sodium superheating of the steam is possible. Gross thermal efficiencies for LMFBR's are presently estimated to be approximately 35 to 41 percent. In Figure 1.2-2, a comparison of thermal efficiencies among fossil, LWR and LMFBR power plants is shown. For the LMFBR demonstration plant, the gross thermal efficiency is estimated to be approximately 39 percent and the net thermal efficiency approximately 36 percent due to in-plant electrical consumption. Thus, a LWR plant of equivalent thermal power to the CRBRP produces a net electrical output of 30 to 58 MWe less than the CRBRP. As more information becomes available on material behavior in high temperature environments, it is anticipated that future LMFBR's will have even higher core outlet temperatures and correspondingly higher thermal efficiencies.

1.2.1.3 ENVIRONMENTAL ADVANTAGES

The CRBRP, as well as nuclear power plants in general, offer distinct environmental advantages over fossil-fuel power plants.

During operation, there are no combustion products such as fly ash and sulfur dioxide emissions continuously released to the environment and no large amounts of fuel such as oil or coal that must be continuously provided in order to insure an uninterrupted supply of electrical power. By eliminating the need for continuous supplies of large amounts of fossil fuels, attendant considerations of spills and other impacts associated with transporting these fuels are also eliminated.

Impacts on the environment due to the removal of these fuels from the earth and transportation to the point of use are also eliminated. In Figure 1.2-3, the relative land areas disturbed by the mining of uranium, coal and oil shale are shown.

A less obvious benefit of the LMFBR, brought about by the decrease in mining and fabrication requirements, is the reduction in occupational accidents associated with the operation of an LMFBR. Figure 1.2-4 shows this reduction in comparison with other types of commercial power plants.

Small amounts of radioactive wastes will be produced during the operation of the CRBRP, as they are produced during the operation of all nuclear power plants. Any releases of these radioative materials are expected to be less than the already insignificant releases from LWR's and well within applicable regulations.

An additional advantage of the CRBRP, and for LMFBR's in general over LWR's, is the reduced heat content of the thermal discharge per kilowatt produced. As described in Section 1.2.1.2, the increased thermal efficiency of the LMFBR over the LWR results in additional electrical kilowatts generated per thermal kilowatt produced. Waste heat discharged to the environment is less for the LMFBR than for the LWR of the same thermal power rating.

1.2.2 CHOICE OF THE LIQUID METAL OPTION

Reactors presently planned or in commercial operation today use a fissile nuclear fuel at a rate which estimates that the U. S. low cost uranium reserves would be consumed in 25 to 50 years, as seen in Figure 1.2-5. The obvious need for a breeder to preserve the nuclear option then leads to the choice of breeder options available. Besides the LMFBR, the three principal candidate alternative breeder reactor types are the Light Water Breeder Reactor (LWBR), the Gas Cooled Fast Breeder Reactor (GCFR) and the Molten Salt Breeder Reactor (MSBR).

The LWBR in a practical sense is more a converter than a breeder, since it does not produce a large surplus of fuel for use in additional reactors. Thus, for an expanding LWBR system, substantial mining and enrichment of additional natural uranium would be required and that concept would ultimately be restricted by uranium availability.

The GCFR uses the same fuel cycle as the LMFBR and fuel utilization incentives are similar. The GCFR is presently behind the LMFBR in development and considerable additional effort would be required to bring this reactor into a commercial operation on the same time scale as the LMFBR. However, if GCFR were developed in parallel with the LMFBR, it could become competitive with the LMFBR as the HTGR is now approaching competitive parity with the LWR.[1] In recognition of the potential of the GCFR, the AEC has undertaken expanded GCFR research and development programs directed toward accelerating development of that option.

The MSBR, which operates on the thorium cycle, offers broader resource utilization, but research and development requirements indicate that this reactor will not be available before 1990. As will be pointed out in Section 1.4, this is not a feasible option within the time scale necessary for the introduction of a breeder.

Choice of the liquid metal option, specifically the LMFBR, for the U. S. Breeder Reactor program was based principally on predicted performance, industrial support, a broad base of technological experience and proven basic feasibility.

Use of liquid sodium offers the best combination of characteristics for the Breeder Reactor. These include: excellent heat transfer properties; low pumping power requirements; low system pressure requirements; the ability to absorb considerable energy under emergency conditions (due to its operation well below the boiling point); a tendency to react with or dissolve many fission products and to retain them within the sodium; and excellent neutronic properties.* Additionally, the U. S. industry has a well established capability for producing high grade sodium in large quantities. There are certain drawbacks, however, associated with its use. These include its chemical reactivity with air or water, activation under irradiation and relatively high melting point. On balance,

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* Neutron collisions with sodium do not appreciably reduce their energy and hence breeding of Pu-239 is still possible. In LWR's, water is used to both remove heat and decrease neutron energy so fissioning of U-235 can occur.

the unique advantages of sodium, along with considerable technology, developmental efforts and operating experience previously acquired with sodium coolants, contribute to the expectation that this reactor system can be brought to a stage of commercial application in a relatively short period of time.

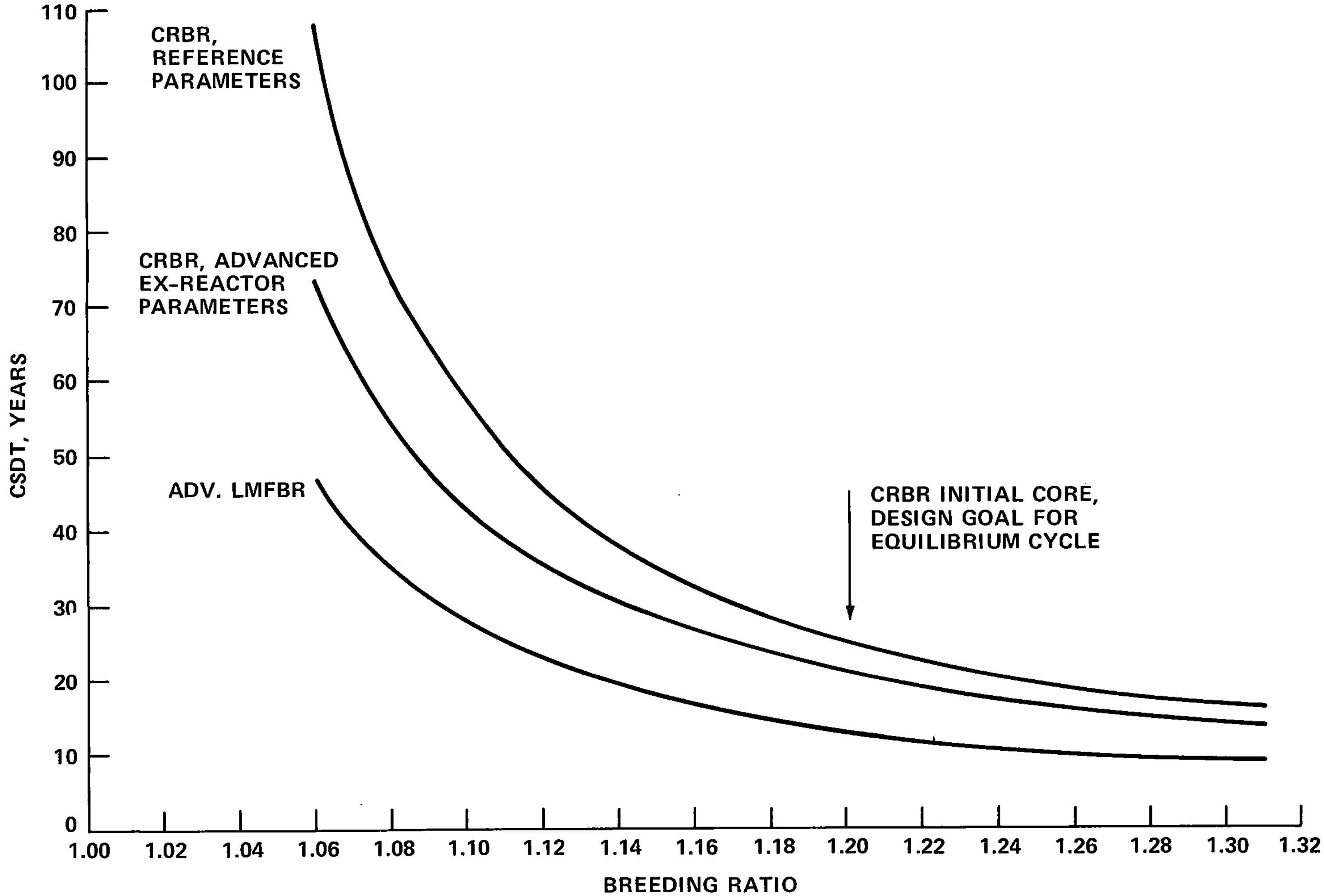


Figure 1.2-1 COMPOUND SYSTEM DOUBLING TIME VS. BREEDING RATIO FOR CRBR AND ADVANCED LMFBR'S

Key - Figure 1.2-1

DOUBLING TIME PARAMETERS

<u>REFERENCE CRBR PARAMETERS:</u>	
SPECIFIC POWER	0.65 MWt/kg
REPROCESSING TIME	12 MONTHS
CORE FRACTION REPLACED EACH CYCLE	0.306
REFUELING INTERVAL	12 MONTHS
LOSS FRACTION	1%
CYCLE LENGTH	275 FPD
<u>CRBR, ADVANCED EX-REACTOR PARAMETERS:</u>	
SPECIFIC POWER	0.65 MWt/kg
REPROCESSING TIME	6 MONTHS
CORE FRACTION REPLACED EACH CYCLE	0.306
REFUELING INTERVAL	12 MONTHS
LOSS FRACTION	0.2%
CYCLE LENGTH	275 FPD
<u>ADVANCED LMFBR PARAMETERS:</u>	
SPECIFIC POWER	1.0 MWt/kg
REPROCESSING TIME	6 MONTHS
CORE FRACTION REPLACED EACH CYCLE	0.306
REFUELING INTERVAL	12 MONTHS
LOSS FRACTION	0.2%
CYCLE LENGTH	275 FPD

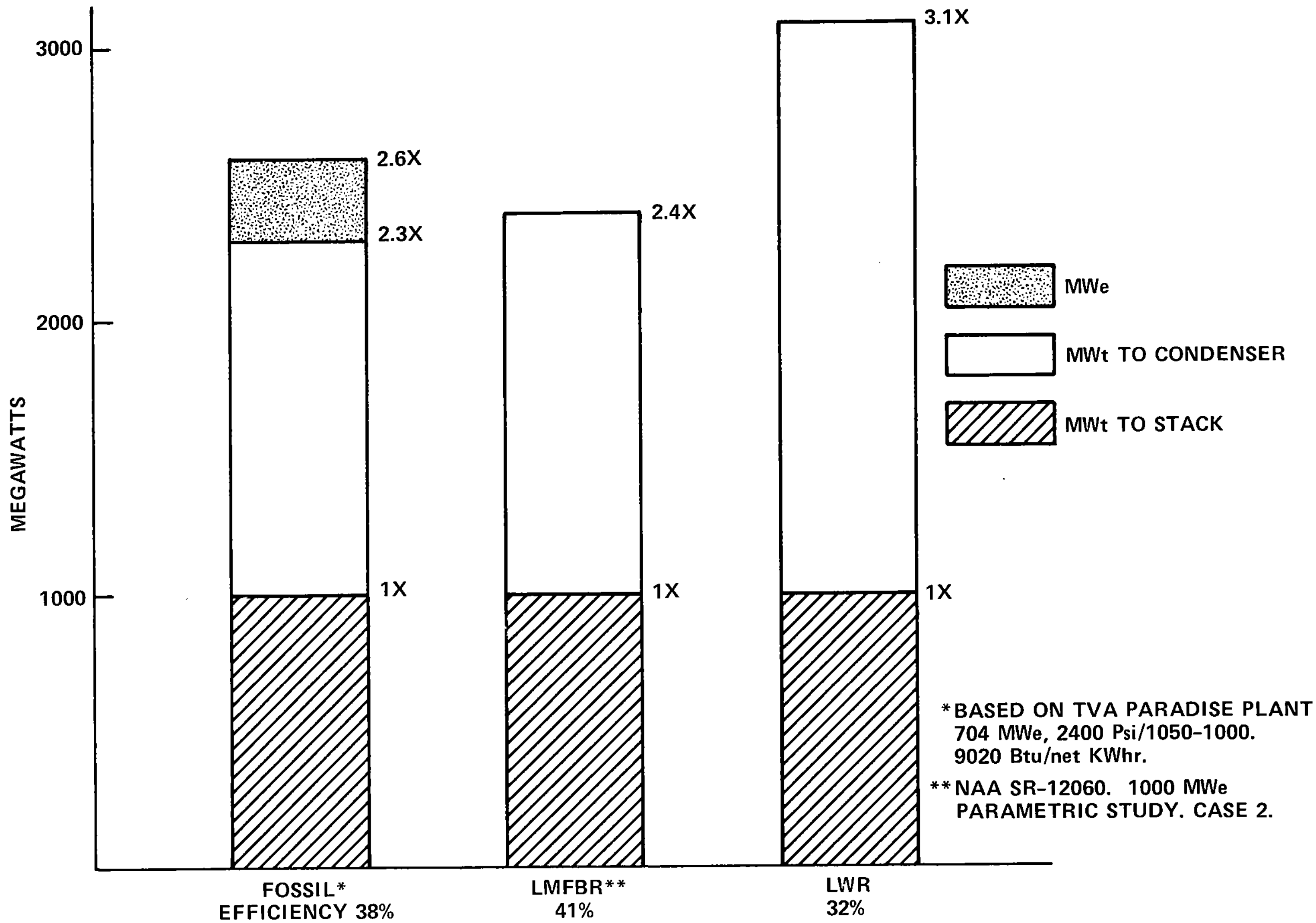


Figure 1.2-2 COMPARATIVE HEAT REJECTION POTENTIAL FROM VARIOUS GENERATING PLANT SYSTEMS

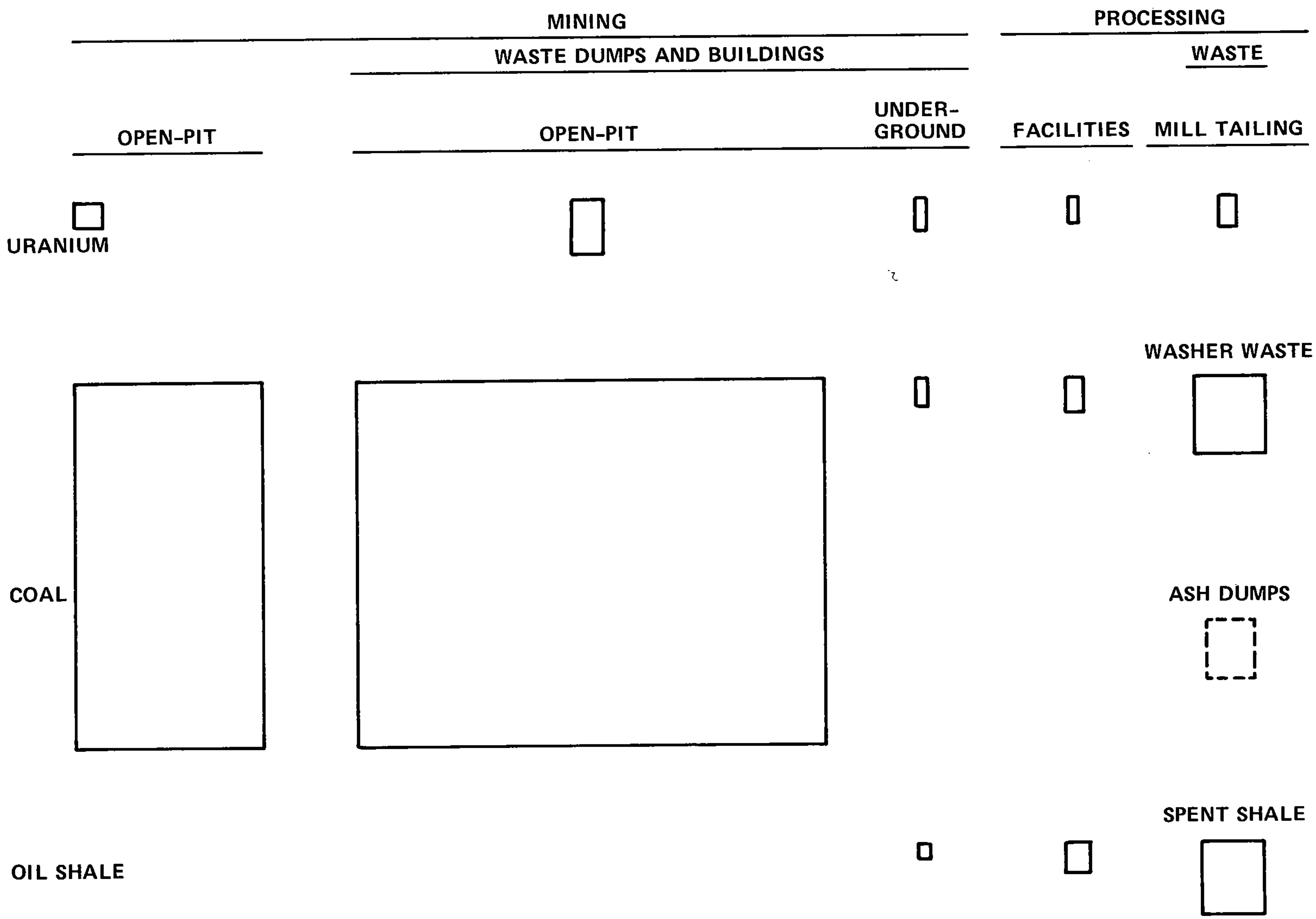


Figure 1.2-3 RELATIVE LAND AREA DISTURBED BY ENERGY FUEL PRODUCTION - 1000 MEGAWATT PLANT

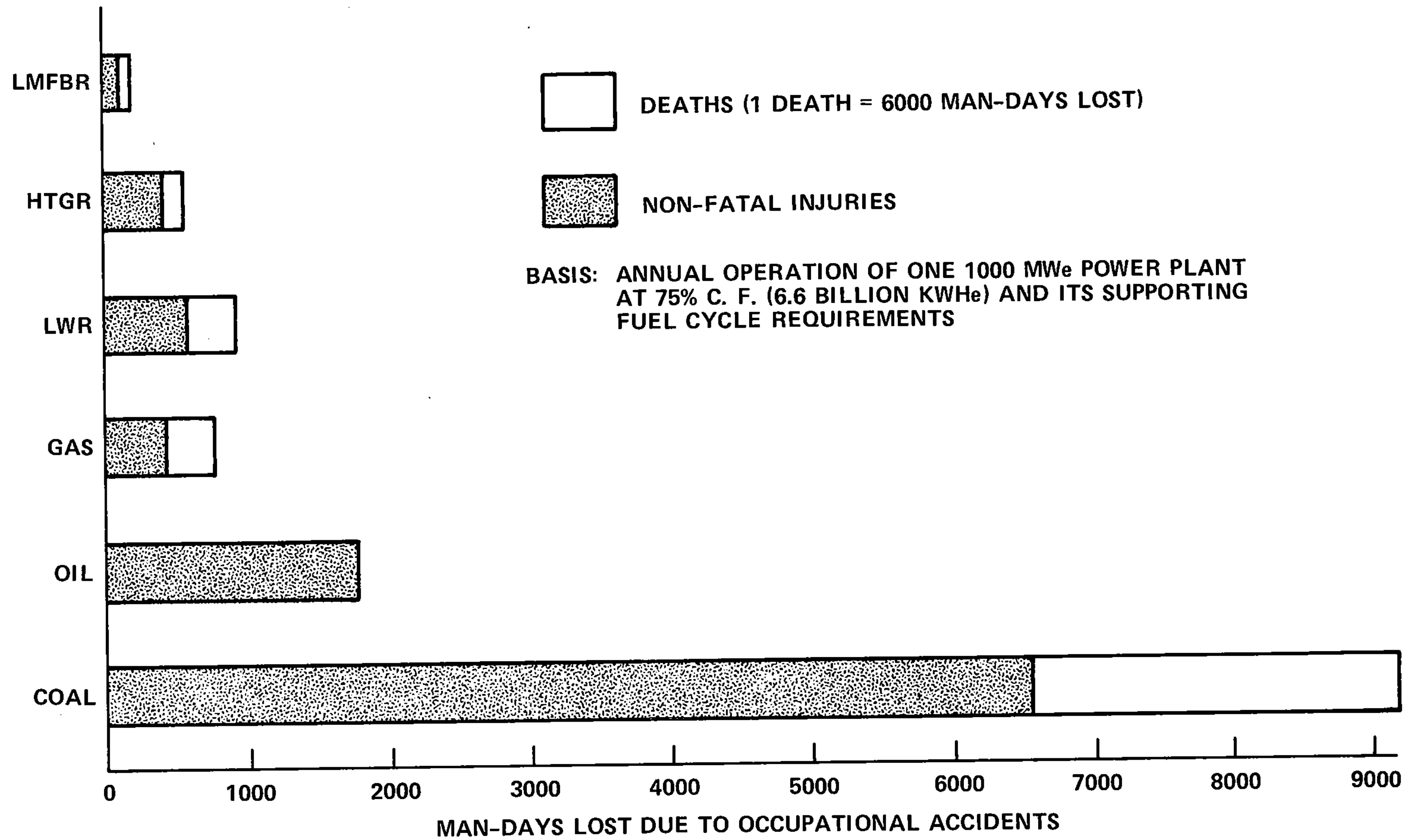


Figure 1.2-4 ANNUAL OCCUPATIONAL INJURIES IN THE ALTERNATE ENERGY SYSTEMS

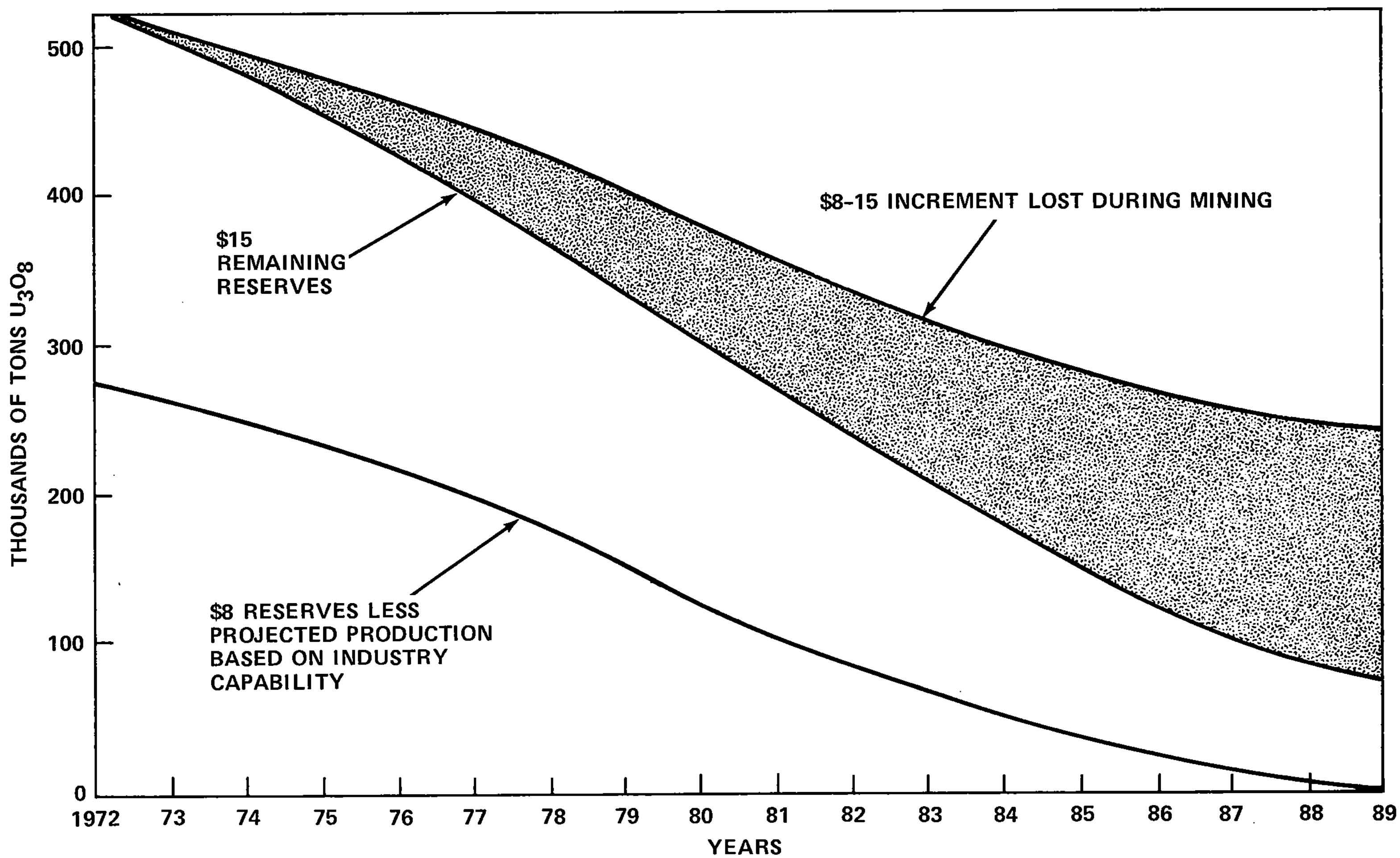


Figure 1.2-5 DEPLETION OF $15 RESERVES AS $8 RESERVES ARE MINED OUT

1.3 NEED FOR THE DEMONSTRATION PROJECT

The advantage of the Breeder Reactor over other alternative energy sources has been recognized by the AEC and others for over one-quarter of a century, and research and development efforts have been underway since then with the final goal being the realization of a large scale commercial LMFBR economy. The undertaking of any large-scale technological program, in this case the Breeder Reactor, is characterized by developmental milestones necessary in achieving the final goal of that program. One of the most significant milestones in the U.S. Breeder Reactor Program is the demonstration of the Liquid Metal Fast Breeder Reactor.

In connection with AEC's basic statutory research and development mission, a series of reactors have for a number of years been specifically authorized by the Congress to show the actual performance and interrelation of important technological, engineering, operational and economic factors. These plants are the culmination of preliminary investigation and theoretical work, exploratory development and experimentation and preliminary conceptual engineering. Over the past quarter of a century, the United States has constructed and operated a number of such demonstration plants including EBR-I, EBR-II, FERMI and SEFOR. Information obtained from the operation of these plants aided in the resolution of many technical uncertainties associated with the LMFBR and led to the conclusion that safe commercial size plants would be technically feasible and economically competitive. The Fast Flux Test Facility (FFTF) reactor is the final test reactor planned in the LMFBR program. Presently under construction at the Hanford Engineering and Development Laboratories (HEDL) in Richland, Washington, it is a large scale test facility designed to provide experimental information in an environment comparable to future LMFBR's. This includes important irradiation testing of a variety of fuels, reactor control materials and structural materials in a controlled and instrumented fast neutron flux. In Figure 1.3-1, a comparative time scale of breeder reactor development is shown for the United States and other countries developing an LMFBR.

As the next logical step in the milestones of the Breeder Reactor Program, once a firm testing and experimental program has been established to provide continuous design information, the capability of the LMFBR as a safe, commercial power producing facility must then be demonstrated. Specifically, the CRBRP will help the utility industry and AEC to:

1. Demonstrate that the necessary technology is indeed available to scale up and successfully construct and operate commercial-sized LMFBR's;

2. Provide a technical basis for extending the technology to future commercial plants where improvements in fuel life, plant capacity and thermal efficiency will be made for economic reasons;

3. Develop operating data on the environmental impact of the LMFBR before large numbers of commercialized LMFBR's are constructed;

4. Provide a demonstration of the nuclear parameters necessary for commercial development;

5. Demonstrate the minimal impact from disposal of radioactive waste materials;

6. Demonstrate the equipment on a large scale; and

7. Demonstrate the breeder concept in an industrial environment.

These seven items are amplified in subsections 1.3.1 to 1.3.5. Subsections 1.3.6 and 1.3.7 discuss the selection of plant size and participation of utilities and vendors in the LMFBR Program, respectively.

1.3.1 DEMONSTRATION OF AVAILABLE TECHNOLOGY

To demonstrate that the required technology is available, the best engineering and manufacturing experience of the CRBRP will be used. This can be illustrated by the following:

1. Manufacturing and testing core hardware prototypical to large size plants - An example is the selected core support structure in the CRBRP. The all-welded assembly, integral with the reactor vessel, combined with modular design core baskets was selected after careful studies were made on a number of non-integral mechanical attachment concepts. The modular feature of the core support structure design was introduced as a direct result of evaluating the engineering, fabrication and performance difficulties associated with extrapolating a FFTF core basket type design to 1,000 MWe plant size. By taking coolant directly from the vessel inlet plenum, the modular design minimizes the potential maldistribution in a large-size plant. It also affords a significant increase in maintenance capability within the range of proven technology. The demonstration of such technology for LMFBR plants is therefore obtained.

2. Designing and testing reliable instrumentation for commercial plants - CRBRP provides a stepping stone in developing, designing and testing instrumentation for a commercial-sized system. Utilizing results of base technology development with experimental systems already tested in small-scale facilities, full scale licensable systems are designed and tested in a utility power plant environment. Examples of these kinds of systems are: the sodium/water reaction pressure relief system which relieves the pressure in order to limit the adverse consequences of a steam generator tube rupture; steam generator redundant auxiliary heat removal system to permit safe plant shutdown for all anticipated events; variable speed full scale sodium pumps to

permit load-following capability on a utility grid; and the fuel failure location capability for large size reactors including core and blanket assemblies to minimize operational costs by reducing down time.

3. Overall prooftesting of components and system - One of the features of CRBRP that involves new design concepts is the diverse, secondary control rod system (SCRS). This feature is incorporated to assure the reliability of the Shutdown System. An extensive qualitative and quantitative reliability program is undertaken which includes the component and prototype testing programs.

4. Developing and applying codes, standards and quality assurance procedures - By following the procedure of system design, construction and operation, the codes and standards (including RDT standards) are being applied to the system and to the individual components in an effective manner that results in procedures acceptable to commercial practice. When a code or standard is not available, one will be developed or an existing code or standard will be modified such that an industrial base is formed to pave the road for commercial plants. Reliable quality assurance procedures will also be established and demonstrated by the successful completion of the construction and achievement of the CRBRP objectives.

1.3.2 EXTENSION OF CURRENT TECHNOLOGY

To project competitive costs accurately in a larger commercial unit, the CRBRP is designed to be as prototypic as possible. While the components need not be identical, the design will enable extrapolation over the required size range with a high degree of confidence. This objective can be best accomplished through in-plant tests, modifications and analyses planned during the five-year period subsequent to initiation of full power operations of the CRBRP. The following phases of demonstration will be carried out:

1. Plant evaluation - The evaluation of the CRBRP as an integrated plant is the most convincing means of demonstrating the feasibility of commercialization to the industry. It is therefore essential that power production capability and satisfactory overall plant efficiency are established. Furthermore, successful demonstration will be made of load-following capability under prototypic conditions of flows, temperatures and pressures and availability on both three and two loop operations of the CRBRP. The plant evaluation will also demonstrate how the plant parameters vary with different power levels and the agreement between the measured parameters and preoperational predictions.

2. Reactor systems evaluation - The overall reactor performance will be compared with design values. This includes comparisons of the nuclear, mechanical and thermal-hydraulic performance of the reactor, control rod and drive system and other in-reactor components. For instance, performance of two different types of fuel assembly will provide a means of assessing improvements in fuel performance and operating conditions. Reactor physics parameters will also be evaluated by determining burn-up, fuel management and control management. Pre-operational physics tests will be made at the start of the first few burn-up cycles of the CRBRP to evaluate the cycle performance as the equilibrium cycle is approached. Overall mechanical and thermal-hydraulic performance evaluation will include response to reactor transients and vibrational behavior where measurements will be compared with predictions from analytical models.

3. Plant systems evaluation - Performance of the heat transport system, fuel handling system, sodium service system, control

system, data handling system and instrumentation and protection system will be evaluated. Of special interest is the evaluation of the performance of the heat transport system and steam generator systems under full and partial load, startup and shutdown conditions. The availability of the power plant may depend on the availability of the steam generator system for which very limited experience exists.

4. Post-irradiation evaluation - Performance evaluation of CRBRP reactor components irradiated under typical reactor operating conditions provide vital information for verifying design analyses predictions, improves confidence in engineering design properties and fabrication methods and eliminates the need for overly conservative safety and uncertainty factors. The post-irradiation examinations and performance analyses on selected components removed from the reactor during initial operations will provide a basis for more economic and efficient design of components for commercial LMFBR plants.

1.3.3 DEVELOPMENT OF OPERATING DATA

The operating data on the environmental impact of the LMFBR will be most effectively obtained through the CRBRP. Such data includes the following:

1. Instrumentation, control and protective systems evaluation - The effectiveness and operational characteristics of the instrumentation system, control system, data handling system and protection system will be determined during the operation of the CRBRP. It will demonstrate: the capability to reliably control LMFBR over the load range within the specified temperature limits; the minimal impact of the plant protection system on the plant capacity factor while providing the assurance of the health and safety of the public; adequate display of information and placement of controls so that operational staff can be minimized to correspond

to the commercial practice; and validation of design and analysis tools through verification of monitored plant conditions.

2. Safety operational analysis - The adequacy of technical specifications related to the health and safety of the public will be determined by the analysis of data taken during the course of operation and from tests performed under post construction and approach-to-power experimental programs. These may be in the form of planned and unplanned tests. The sources of planned tests include pre-critical testing and operation, initial core loading and low power tests, approach-to-power and full power testing. Unplanned events which would provide additional data refer to the possibility of inadvertent scrams and power setbacks, malfunction of a system or component and procedural errors.

It is evident, therefore, that the CRBRP will demonstrate the technology of design, fabrication and construction of components and systems, and provide operation and performance evaluations needed for commercial development of breeder reactors.

1.3.4 DEMONSTRATION OF NUCLEAR PARAMETERS NECESSARY FOR COMMERCIAL DEVELOPMENT

The CRBRP will demonstrate the safety and reliability of operating LMFBR's in an utility environment. In addition, certain key nuclear characteristics and capabilities prototypic of large-scale commercial plants will be verified. These characteristics include the development of high performance fuel and blanket assembly designs and the establishment of rapid fuel handling and processing cycles. Advances in the design technology in the CRBRP will be dictated by economic (power generation costs) as well as safety and reliability considerations. The development of high performance fuels and the establishment of rapid fuel processing cycles are necessary capabilities in order for the fissile fuel doubling time (a measure of the rate of increase of available fissile material) to be compatible with the projected energy demand growth rate and therefore, for efficient utilization of nonrenewable natural resources.

The CRBRP will demonstrate that commercial-type breeding ratios (that is, breeding ratios which will assure the potential for economic success of the LMFBR) can be attained in a utility environment with utility-grade plutonium fuels (light water reactor discharge) and with due consideration for the overall power and fuel cycle costs. The CRBRP will be employed to develop high breeding, power density and burnup performance fuels and it is a vital link in the resolution of technical uncertainties which will enable the subsequent optimization of power generation and fuel cycle costs for large scale commercial LMFBR's. A design goal of the CRBRP is the demonstration of a breeding ratio not less than 1.2. Equilibrium fuel and blanket assembly designs developed for this purpose will be prototypical of designs utilized in commercial scale LMFBR's to obtain breeding ratios in excess of 1.3. CRBRP operates at a relatively high power density (peak linear power of 14.5 kW/ft) which is intermediate between existing small scale experimental facilities and large scale commercial LMFBR's. High-strength, low-swelling, cladding and structural alloy materials must be developed in order to maximize the fuel pellet volume fraction (and hence the breeding ratio) and to achieve the high peak burnup and fluence capabilities required to minimize fuel cycle costs.

The fuel selected for the initial CRBRP core is a mixture of plutonium and uranium oxide. This choice is based on the existence of a strong industrial base of experience for fabrication and reprocessing of oxide fuel as well as a good understanding of the behavior of oxide fuel under irradiation. The CRBRP will have the capability of accommodating advanced fuels -- such as carbides and nitrides -- although these will not be used in the initial core because the present state of technology is less advanced than that for oxide fuels.

The AEC's program for the development of advanced fuels includes the development of carbide and nitride fuels. These fuels, by virtue of their higher fissile atom densities and specific power capabilities, offer the potential for shorter doubling times than oxide fuels. Such shorter doubling times are desirable from the standpoint of increasing the Nation's fissionable fuel resources. These advanced fuels will be extensively tested in EBR-II and FFTF prior to any use in the CRBRP. This testing (in EBR-II and FFTF) will confirm the necessary performance characteristics, reliability and economics of these advanced fuels.

The reactor core environment in CRBRP (neutron flux density and spectrums, coolant temperature conditions, etc) and the planned operating philosophy are prototypical of large scale commercial plants so that the required alloy materials can be qualified in the appropriate high-fluence fast environment.

A significant design consideration in satisfying the economic objectives of the LMFBR is the mass of fissile material produced over a period of time, or the rate of fissile mass gain which is related to the doubling time. The doubling time is dependent on the breeding gain, the fissile material investment in the reactor core as well as that tied up in fabrication and reprocessing and the quantitative fissile material losses in fabrication and reprocessing. Rapid and efficient fuel fabrication and processing serves to minimize the required out-of-reactor fuel investment and the material losses and hence to improve the doubling time. The CRBRP will demonstrate the technology required to develop Ex-Vessel Transfer Machines (EVTM) which are capable of rapidly and safely handling high burnup discharge fuel and blanket assemblies with decay powers typical of large scale LMFBR's. In-Vessel and Ex-Vessel fuel storage facilities and shipping containers capable of handling and transporting these high burnup fuels without lengthy cooldown requirements will be developed and employed in the CRBRP. The demonstration reactor will also stimulate the commercial establishment of both reprocessing and fuel fabrication technologies and facilities for the large scale extractions of bred plutonium from high burnup discharge LMFBR fuel and blanket assemblies, and for commercial fabrication of mixed oxide fuels containing (radioactive) utility-grade plutonium. The CRBRP, with a linear power rating of 14.5 kW/ft, an equilibrium breeding ratio of 1.2 and an assumed one percent fissile mass loss in fabrication and reprocessing has a compound system doubling time of approximately 30 years. With reasonable anticipated advances in fuel design technology and rapid and efficient fuel processing, demonstrated in CRBRP, the doubling time in commercial scale LMFBR's will be on the same order as the projected energy-demand growth rate (less than 10 years).

1.3.5 DEMONSTRATION OF THE MINIMAL IMPACT ON THE ENVIRONMENT FROM DISPOSAL OF RADIOACTIVE WASTE MATERIALS

As is typical of all nuclear power plants, the CRBRP plant will produce small amounts of gaseous, liquid and solid radioactive waste materials. These wastes, with a few exceptions, will be similar to those associated with light water nuclear plants. Because of this similarity and CRBRP design basis, the CRBRP is expected to have a minimum impact on the environment resulting from radioactive waste disposal. The technology utilized in waste disposal is that which is currently being routinely used for light water plants. Those types of operations which are unique to the CRBRP require no additional development beyond that which has been carried out for the FFTF.

Some unique benefits result from the inherent nature of a sodium-cooled reactor in the processing and disposing of gaseous wastes. Some of the gaseous or volatile fission products such as tritium and iodine are to a large extent captured and retained in the coolant through chemical interaction with the liquid sodium. Those which are not retained by the sodium will be collected in the cover gas and subsequently removed by the radioactive gas removal systems, which are designed to remove virtually all fission products from the various inerting and cover gases.

Low level and intermediate level liquid wastes will result from cleaning, decontamination and laboratory operations. These are removed conventionally from the liquid effluent by filtration, evaporation and ion-exchange methods. The resulting concentrates containing the radionuclides will be solidified and stored as solid wastes.

Solid wastes will consist of the normally expected compactables (plastic bags, foot covers, towels, protective clothing), solidified liquid radwaste and contaminated tools and hardware. These will be compacted and packaged for burial and disposal. Techniques for processing wastes containing sodium or sodium contamination are part of investigations carried out for the FFTF. These techniques and other procedures utilized by the FFTF will be applied for similar wastes generated by the demonstration plant.

The CRBRP and FFTF will demonstrate for future commercial plants the capability to handle, process and dispose of sodium contaminated wastes with minimum impact on the environment.

1.3.6 DEMONSTRATION OF EQUIPMENT ON A LARGE SCALE

Future commercial LMFBR's are anticipated to operate in the range of 1,000 MWe (approximately 2,500 MWt) to make them economically competitive with existing fossil and light water reactor power plants. Application of existing LMFBR operational and design experience to a plant of this size would require considerable extrapolation of present design technology and engineering and capital cost increases.

Careful consideration was given by the AEC in arriving at the CRBRP size. A design power of 300-500 MWe was selected principally based on the ability to successfully attain the demonstration plant objectives while accommodating the technical and economic risks associated with attaining those objectives. In general, the plant must be small enough to permit practical and confident extrapolation of components and equipment with a reasonable financial investment, yet be large enough to test performance of large systems prototypic of future large scale commercial LMFBR's. Construction of a plant smaller than 300-500 MWe was considered not advantageous since it would be in effect similar in many aspects to the FFTF (300 MWt) presently under construction. Design experience and optimization with respect to extrapolation to a larger commercial plant would not be realized and a 300-500 MWe plant would still have to be built to meet the program objectives.

The alternative approach of going directly from FFTF to a commercial size (1,000-1,500 MWe) LMFBR would require a substantial increase in research and development efforts with associated cost increases and the probability of successful operation would be decreased.

The present plant size of 975 MWt was arrived at after extensive studies were carried out by both the AEC and the reactor manufacturers. Of major consideration was the present capability of the reactor designers and component vendors to confidently design and construct components that meet the higher than normal standards for reactor design and yet keep design, development and manufacturing costs from being prohibitive.

Integral to the constraints of vendor capabilities for component development is the additional constraint of time necessary for development of a LMFBR industry. There are presently a limited number of vendors that have the engineering expertise to develop and design LMFBR components and/or the facilities necessary to fabricate and construct LMFBR components. While considerable experience was gained in the design of the FFTF, it was not sufficient for vendors to believe they could confidently extrapolate designs to commercial scales. Furthermore, present manufacturing capabilities cannot produce components of the size required for a commercial plant. For example, the diameter of the IHX (intermediate heat exchanger) tubesheet forging which is presently commercially available is less than 10 feet. The present CRBRP tubesheet forging is 86 inches. Thus, increasing the IHX size necessary for commercial plants would require the tubesheet diameter to increase and thus the forging capability to also be increased, also with attendant problems.

Similar problems presently exist for the main sodium pumps regarding bearing and seal design, as well as rotor dynamics and impeller stresses.

It should be pointed out however, that the plant is prototypic of future commercial plants in that it will demonstrate essentially all of the principal reactor plant system concepts and functional design features. This includes operation, performance, arrangement and maintainability. In Table 1.3-1, the prototypicality of demonstration plant systems and components to commercial plants is given and in Table 1.3-2, a principal design parameters comparison between the demonstration plant and a typical commercial plant is given.

This phased increase in power ratings approach is similar to that approach used in LWR's.[1] By providing a more solid technological and experienced base, increased confidence in achieving reliable operation can be realized on a shorter time scale and a lower cost. Without the benefit of the CRBRP, the probability of not meeting the program goal of demonstrating reliable and safe operation of the LMFBR in a utility environment in the early 1980's will be greatly increased.

1.3.7 UTILITY AND VENDOR PARTICIPATION IN THE LMFBR PROGRAM

As part of the overall LMFBR program, the CRBRP demonstration plant project is the first point at which utility companies become deeply involved in the LMFBR concept. Seven hundred electric systems have pledged funds to the Project and have formed the Breeder Reactor Corporation (BRC). BRC is the coordinating point for financial and other participation in the Project by the Nation's electric utilities and is the Project's principal liason with the utilities. The utilities involved in the Project evaluate the technology in terms of their needs and methods of operation thereby factoring utility requirements into the Project. At the same time, the utilities will develop the capability to obtain and operate power plants of the LMFBR type.

This project also constitutes a step increase in the involvement of industrial suppliers. There is a commercial overtone to the relationship since it is expected that the utilities will make future purchases from the vendors. At this point the development of the industrial base broadens. It is intended that the industrial base will develop enough breadth so that utility purchasers will, in the future, have a selection of vendors and reliable components from which to choose.

TABLE 1.3-1

PROTOTYPICALITY OF CRBRP SYSTEMS AND COMPONENTS FOR COMMERCIAL PLANT APPLICATION

I. Principal system and plant design features that are directly prototypic, based on current design and development programs:

Reactor system design

Reactor refueling system concept

Heat transport system design and configuration

Basic loop piping arrangement with multiple, separated loops in individually inerted cells

Hydraulic profile employing elevated piping and guard vessel concept

Natural circulation capabilities

Steam generator system design

Sodium-water reaction detection, location, migration and protection

Plant arrangements to facilitate maintenance

Containment concept and design

Sodium and inert gas processing systems and components

Overall plant control system

Plant protection system

Instrumentation and control systems and components

Auxiliary cooling and service systems and components

II. Principal plant analysis techniques, standards and design practices that are directly applicable:

High temperature structural analysis criteria and techniques

Seismic design criteria and analysis techniques

(Continued)

TABLE 1.3-1 (Continued)

Plant duty cycle development and thermal transients definition, analysis and mitigation techniques

Basic materials selection and physical properties

Material and process standards

Sodium component and piping fabrication practices, techniques and standards

Design codes and standards

Quality assurance standards and practices

Plant operating procedures and maintenance procedures

Safety evaluation and analysis criteria and techniques

TABLE 1.3-2

PRINCIPAL DESIGN PARAMETER COMPARISON

CRBRP AND LMFBR COMMERCIAL PLANT

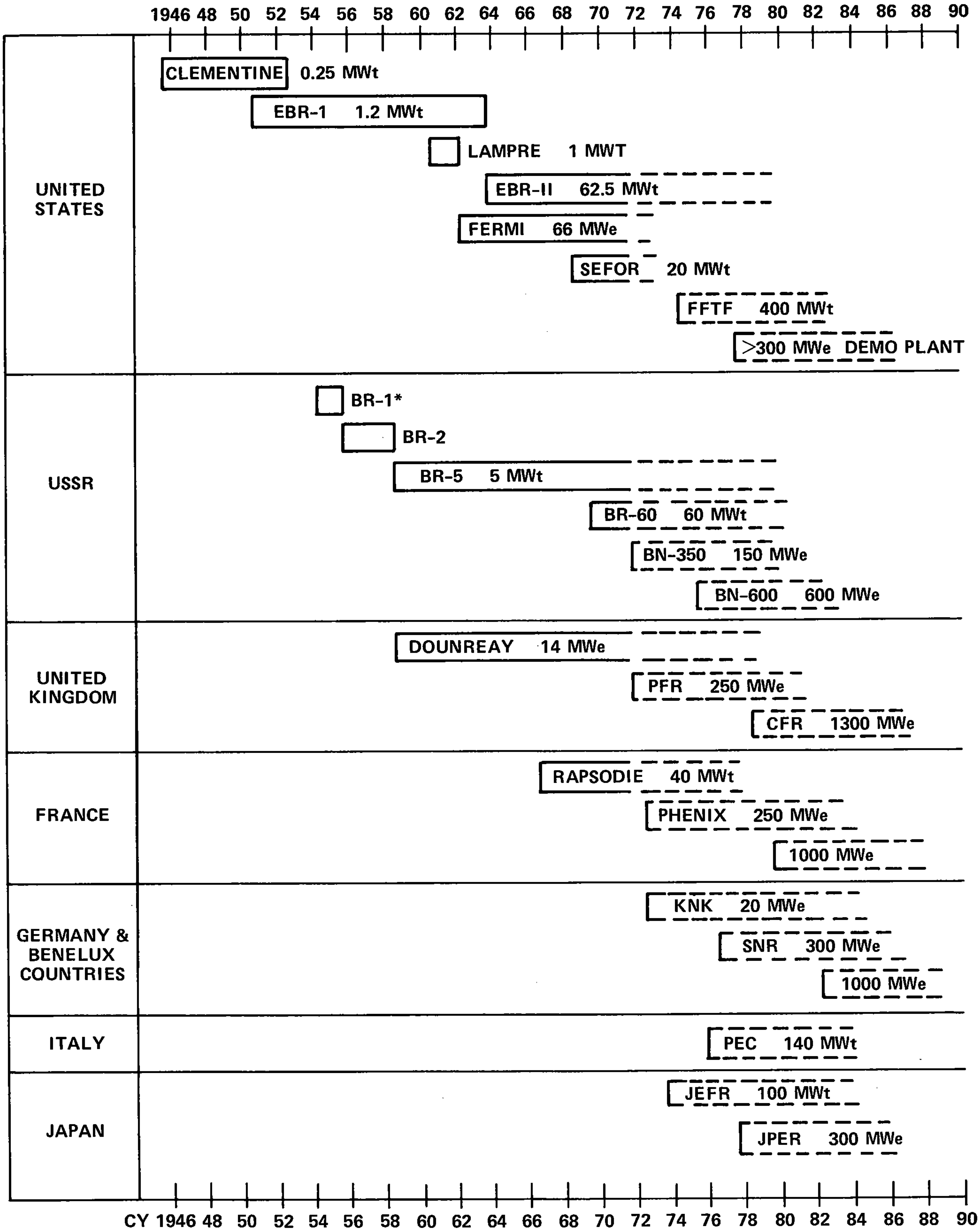
Design Parameter	CRBRP (3 Loops)	Typical Commercial Plant (3 Loops)	Typical Commercial Plant (4 Loops)
Reactor Thermal Power, MWt	975	2750-4150	
Net Power Output, MWe	350	1000-1500	
Cycle Efficiency, %	36	≥ 36	≥ 36
Primary Hot Leg Operating Temperature, °F	995	1000	1000
Δ Temp., Primary System, °F	265	≤ 275	≤ 275
Primary Flow, per loop, GPM	33,500	95,000*	72,000*
Primary Pump Head, ft	450	450	450
Primary Pump Location	Hot Leg	Hot or Cold Leg	
Primary Pipe Size, in.	24 Cold Leg	45*	36*
	38 Hot Leg	40-56*	36-50*
Steam Pressure, at turbine, psig	1450	1450 or 2400	
Steam Temp., at turbine, °F	900	900	
Feedwater Temperature, °F	452		

(Continued)

TABLE 1.3-2 (Continued)

Design Parameter	CRBRP (3 Loops)	Typical Commercial Plant (3 Loops) (4 Loops)
Steam Generator Type and No. of Evaporator and Superheater Modules/Loop	$\leq$ 3, Forced Recirculating Type	1 or multiple number Recirculating or once through type
Reheater Provision	None	Reheat probable
Containment Type	Steel Cylinder	Steel cylinder or steel-lined concrete, or confinement concept
Dia., ft.	<186	$\sim$ 225

*Based on 1000 MWe size



*THE DESIGNATIONS BR-1, BR-2 AND BR-5 REFER TO THE SAME FACILITY MODIFIED TO OPERATE AT SUCCESSIVELY HIGHER POWER LEVELS

Figure 1.3-1 LMFBRs - U. S. AND WORLD-WIDE

1.4 IMPORTANCE OF TIMING AND CONSEQUENCES OF DELAY

The date of introduction of the Liquid Metal Fast Breeder Reactor (LMFBR) into the economy has a significant effect if future energy requirements are to be met and energy costs remain reasonable.

Present program goals call for an introduction date of 1987 for the commercial breeder. The benefits accrued, as measured by this date, are most sensitive to uranium resource availability. As stated in WASH-1535, "The penalty for delaying the breeder with an optimistic uranium price projection is about $.75 billion per year and about $3.4 billion per year for the low uranium availability projection." In general, every year of delay beyond 1987 will cost the Nation about $1.25 billion per year in higher costs of electric power.

1.4.1 URANIUM RESOURCE UTILIZATION INTRODUCTION DATE

As stated previously, present projected demands for uranium to fuel Light Water Reactors (LWR's) and High Temperature Gas Reactors (HTGR's) indicate depletion of low cost reserves within the next 25 to 50 years. Heavier reliance on extraction from low grade ores and recoverability as a by-product from phosphate deposits is expected to increase the cost of refined U_3O_8 from $3.00 per pound to approximately $100 per pound by the year 2020. In Figure 1.4-1, a comparison of cumulative U_3O_8 usage is made for varying LMFBR introduction dates with the limit being no introduction at all.

Besides the environmental advantages of decreased uranium ore requirements, introduction of the commercial LMFBR by 1987 will reduce the cost of U_3O_8 to approximately $24 per pound by 2020, as compared to approximately $44 per pound if the introduction date is delayed until 1991. This is shown in Figure 1.4-2.

The overall impact of the commercial LMFBR introduction date on uranium resource utilization is that uranium ore requirements (mining) and uranium ore costs are significantly reduced (and as a consequence will reduce electrical energy cost increases) by introducing the commercial breeder reactor as early as possible. As previously indicated, the CRBRP is an essential step toward development of large scale commercial LMFBR's. Thus, introduction of the CRBRP must proceed on a rigid time scale if the maximum benefits of early commercial introduction are to be realized.

1.4.2 SEPARATIVE WORK

The increasing U_3O_8 ore requirements required to fuel a LWR and HTGR industry will be accompanied by correspondingly increasing separative work requirements.

As shown in Figure 1.4-3, delaying the introduction of the commercial breeder by four years to 1991 increases the maximum demand from about 105 million separation work units (SWU's) to about 119 million SWU's, delays the year of maximum demand four years and increases the cost of the maximum annual separative work (based on $36/SWU) by about $0.5 billion.

1.4.3 ENVIRONMENTAL IMPACTS ASSOCIATED WITH DELAY

If the introduction date of the breeder reactor is delayed, generating capacity scheduled to be supplied by the LMFBR must be met with other energy producing systems, such as LWR's or fossil-fuel power plants. As such, more adverse environmental impacts associated with these means of energy production as compared to the LMFBR (see Section 1.2.1.3) must be accepted to meet the energy demand.

Meeting the needed generating capacity with additional LWR's will increase uranium ore requirements and land use requirements for mining, as well as increasing the depletion rate of the known uranium resources. Furthermore, meeting the demand with LWR's will increase the total thermal energy discharged to water bodies (rivers, lakes, etc.) to a greater extent than if the demand were met with LMFBR's or fossil-fuel power plants.

The use of fossil-fuel plants to meet the required generating capacity will increase use of coal or oil supplies. The use of coal leads to undesirable stack emissions and additional costs would be incurred to develop and construct the necessary equipment to reduce these emissions.

Also, increased coal demand would commit more land for mining purposes and risks associated with coal mining would subsequently increase.

The low reserves and increasing costs of oil, along with the risks associated with its reliable supply, as evidenced by the recent oil embargo, do not make oil-fuel power plants a desirable replacement for delayed LMFBR generating capacity. This would increase the oil demand which in turn would increase exploration efforts, such as off-shore drilling (with its associated risks) or require more costly means of extraction from the environment (shale oil with associated large land commitments).

In summary, by delaying the demonstration plant, which in turn, delays the introduction of commercial breeder reactors, the environment will be impacted adversely to a greater extent than if the breeder were not delayed. Timely introduction of the breeder will decrease the thermal discharges to bodies of water and minimize land use requirements for the extraction of fuel from the environment.

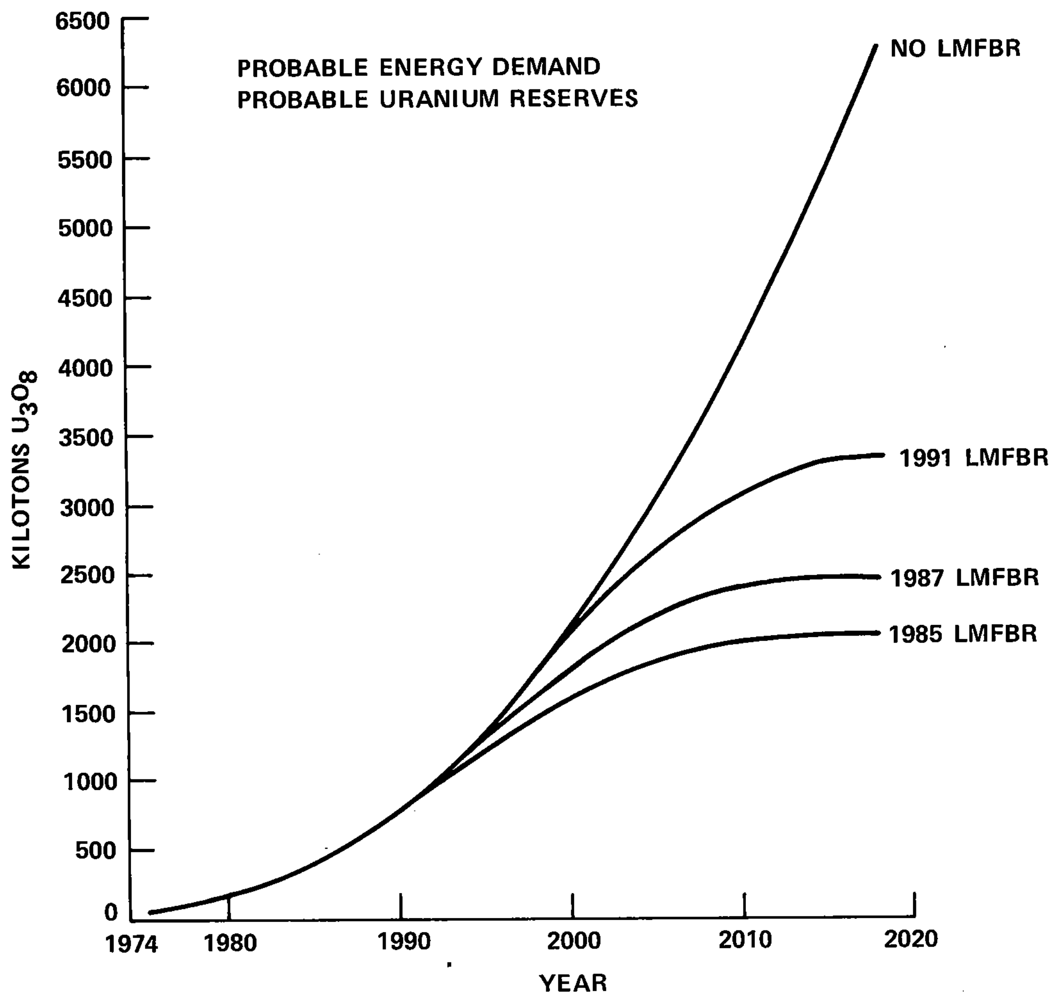


Figure 1.4-1 CUMULATIVE U_3O_8 USAGE

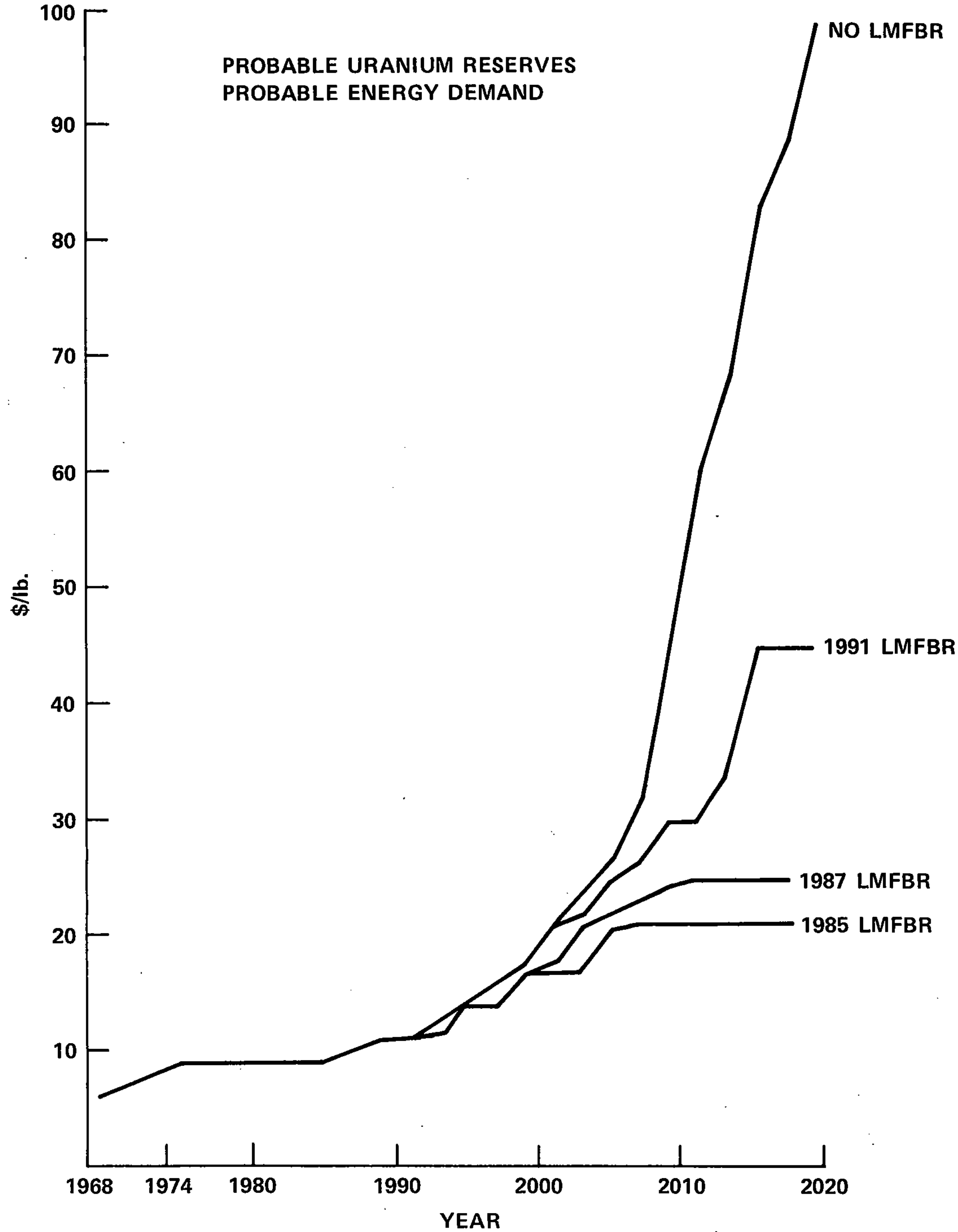


Figure 1.4-2 U_3O_8 PRICE

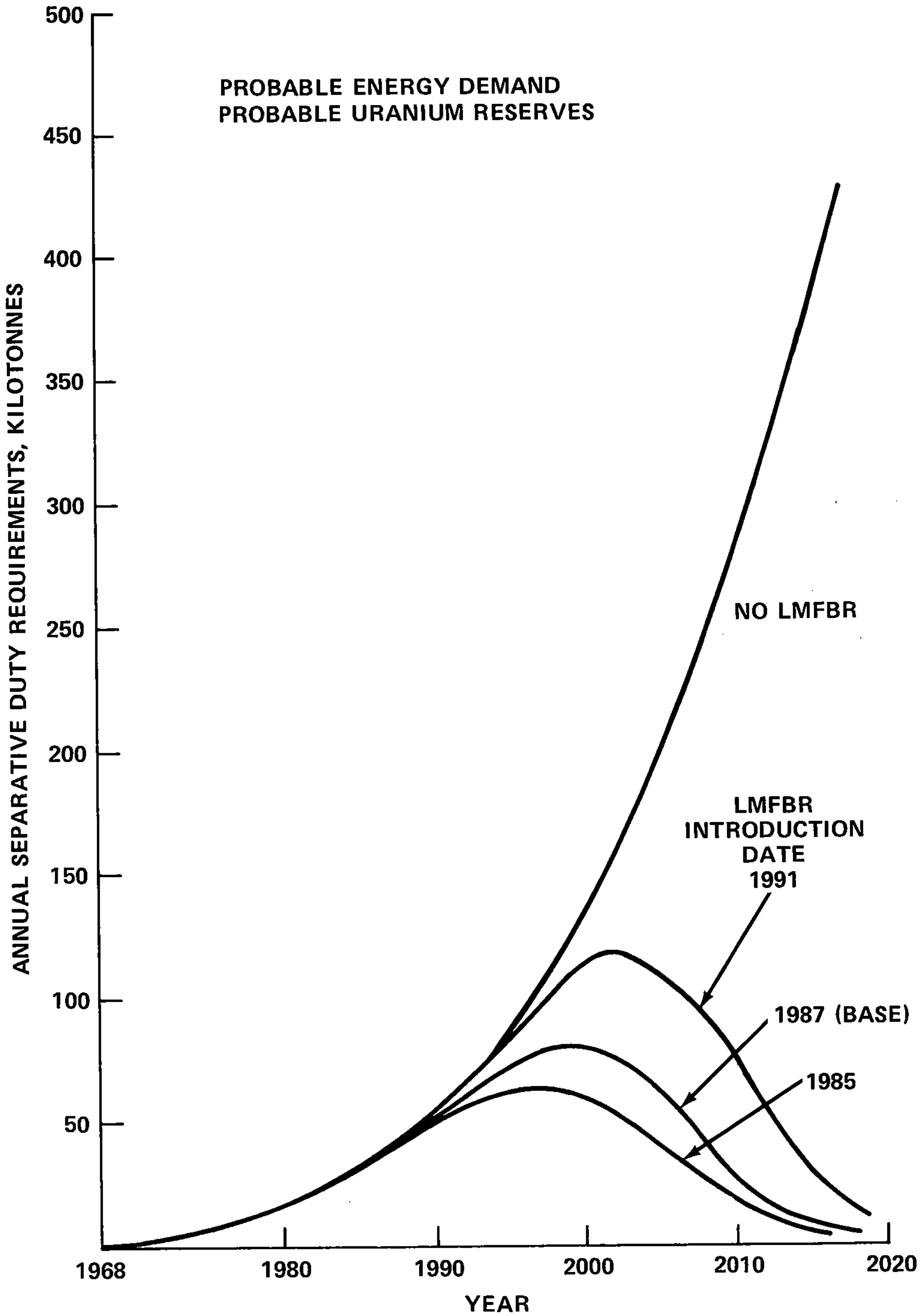


Figure 1.4-3 SEPARATIVE WORK DEMAND VERSUS LMFBR INTRODUCTION DATE

1.5 SUMMARY

The timely introduction and successful operation of the Clinch River Breeder Reactor Plant (CRBRP) will establish the viability of the Liquid Metal Fast Breeder Reactor (LMFBR) as a reliable, safe and environmentally acceptable source of electrical energy. It will also provide a major contribution to the technical knowledge that is necessary to establish a commercial LMFBR industry. Because of the breeding nature of this reactor, more efficient use of the energy available from uranium will greatly reduce uranium mining and separative work requirements, as well as help conserve other non-renewable energy resources.

The benefits which accrue to the Nation from the LMFBR are both significant and strongly time dependent since the CRBRP is the essential link in the change of events leading to a commercial LMFBR economy. The maximum benefits can only accrue if the CRBRP is completed as rapidly as possible.

2.1 SITE LOCATION AND LAYOUT

The Clinch River Site is located in east central Tennessee in the eastern part of Roane County as shown in Figure 2.1-1. Knoxville, Tennessee, is located approximately 25 miles east of the Site. Cities located within a 10-mile radius of the Site are Lenoir City, about 8.5 miles southeast; Kingston, 7 miles west; Harriman, 9.5 miles west-northwest; and Oak Ridge, 9 miles northeast. Although the Site is technically within the city limits of Oak Ridge, it is located in the southwestern section on undeveloped property which is owned by the U.S. Government and is in the custody of the Tennessee Valley Authority (TVA). Location of the Site with respect to its proximity to urban centers, railroads and highways within a 10-mile radius is shown in Figure 2.1-2.

The Site is located on a peninsula formed by a meander of the Clinch River between river miles 14.5 and 18.6. It is bounded on the north by AEC's Oak Ridge Reservation. Of the 1,364 acres within the Site boundaries, approximately 100 acres (7%) will be required for the Clinch River Breeder Reactor Plant (CRBRP) and related facilities such as roads, railroads and transmission line corridors. The Reactor Containment Building and its auxiliary buildings will occupy about four acres. Estimates of the amount of acreage required for various construction activities are given in Section 4.1.

A portion of the Site to the north of the plant, between Bear Creek Road and Grassy Creek, has been set aside for industrial development and is called the Clinch River Consolidated Industrial Park (CRCIP). Approximately 112 acres will be occupied by the CRCIP and the remaining acreage will be available to TVA for future utilization. Figure 2.1-3 shows the plant's facilities in relation to the Site and the CRCIP.

Coordinates of the center of the containment location for the CRBRP are given below in both latitude and longitude and Universal Transverse

Mercator (UTM) coordinates. Latitude and longitude are given to the nearest second and UTM coordinates are given to the nearest 100 meters. (Coordinates used on figures in this report are U.S.G.S. mapping coordinates.)

Latitude and Longitude	UTM Coordinates
35° 53'24"N x 84° 22'57"W	$39_{74}709_N$ x $7_{36}262_E$

A security barrier -- fence -- shown in Figure 2.1-4, will enclose the buildings, systems and auxiliary facilities essential for safe operation of the plant. A patrol road will parallel the inside of the security barrier and will provide a clear, unobstructed view both inside and outside the fence. Minimum exclusion area distance is 2,200 feet from the center of the Reactor Containment Building. The exclusion area includes the Site (except for the industrial park) and the river adjacent to the Site, as shown in Figure 2.1-3. Control within the exclusion area, excluding the waterway, will be by the applicant. Control of the waterway will be coordinated with the appropriate agencies and the river bank will be marked and posted to prevent any private or commercial use of this area.

Grade for the main plant structures has been established at 815 feet above mean sea level (MSL), placing it 74 feet above the mean Clinch River water level of 741 MSL. Figure 2.1-4 shows the arrangement of the plant structures. Structures marked with an asterisk are designated as safety related or Category I structures. A one-story Training Center Building, which will contain office facilities and an auditorium, will be located outside the security barrier approximately 100 feet northwest of the Gatehouse along the access road as shown in Figure 2.1-4.

Road access to the plant will be along the existing River Road from the northwest boundary, as shown in Figure 2.1-3. At the eastern boundary of the Site, River Road will be barricaded and locked, to be opened only in case of emergency. Railroad access to the Site will be provided from the AEC's existing facilities at the Oak Ridge Gaseous Diffusion Plant to the north of the Site and will run parallel to the Site access road.

Steep limestone ridges, hills and knobs are characteristic features of the region. In the Site area, Chestnut Ridge is dominant, cresting at about elevation 1,100 feet. A floodplain borders the western side and the southern tip of the peninsula, but is essentially absent from the eastern border. There are no perennial streams at the Site; flow along valleys and gullies occurs only after periods of heavy rainfall. Figure 2.1-5 is a topographical map of the region; an aerial view is presented in Figure 2.1-6.

Within a two-mile radius of the Site, the area consists primarily of woodland; however, small farms and residences are scattered throughout the area south of the Clinch River. Figure 2.1-7 shows the farms, dwellings, industries and wooded areas within a two-mile radius of the Site.

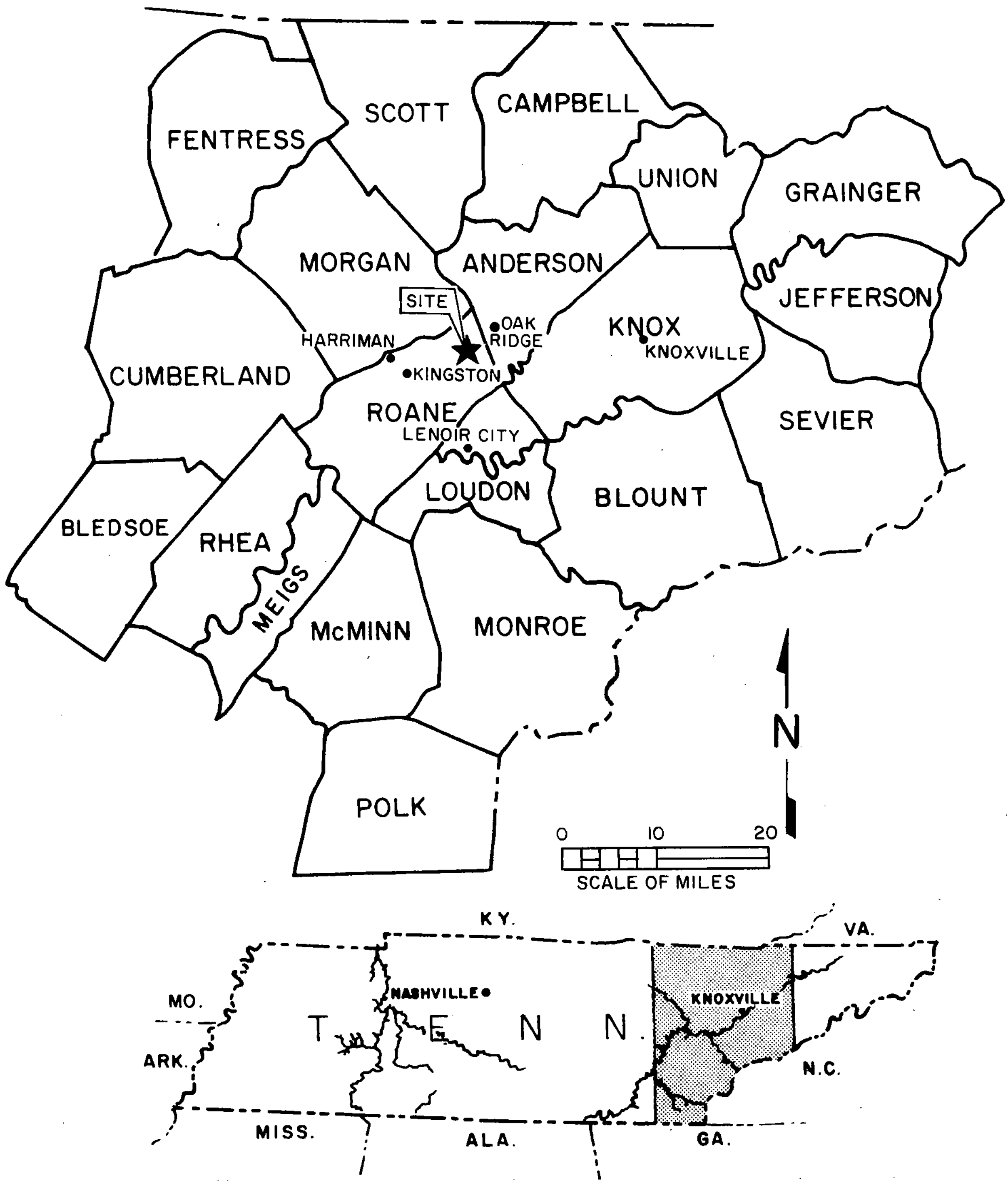


Figure 2.1-1 LOCATION OF CLINCH RIVER SITE IN RELATION TO COUNTIES AND STATE

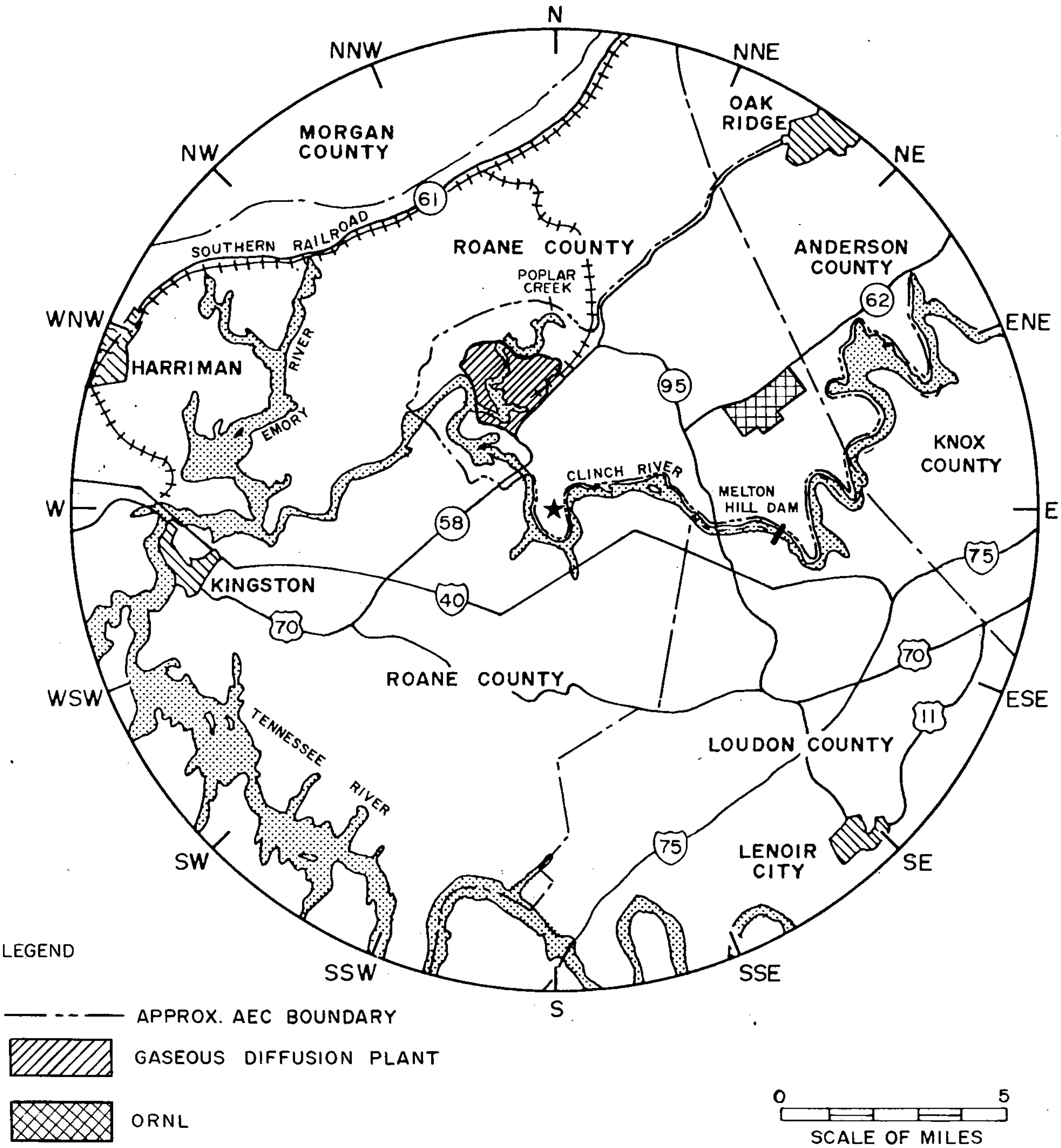


Figure 2.1-2 LOCATION OF SITE WITH RESPECT TO URBAN CENTERS, RAILROADS AND HIGHWAYS WITHIN A 10-MILE RADIUS OF THE SITE

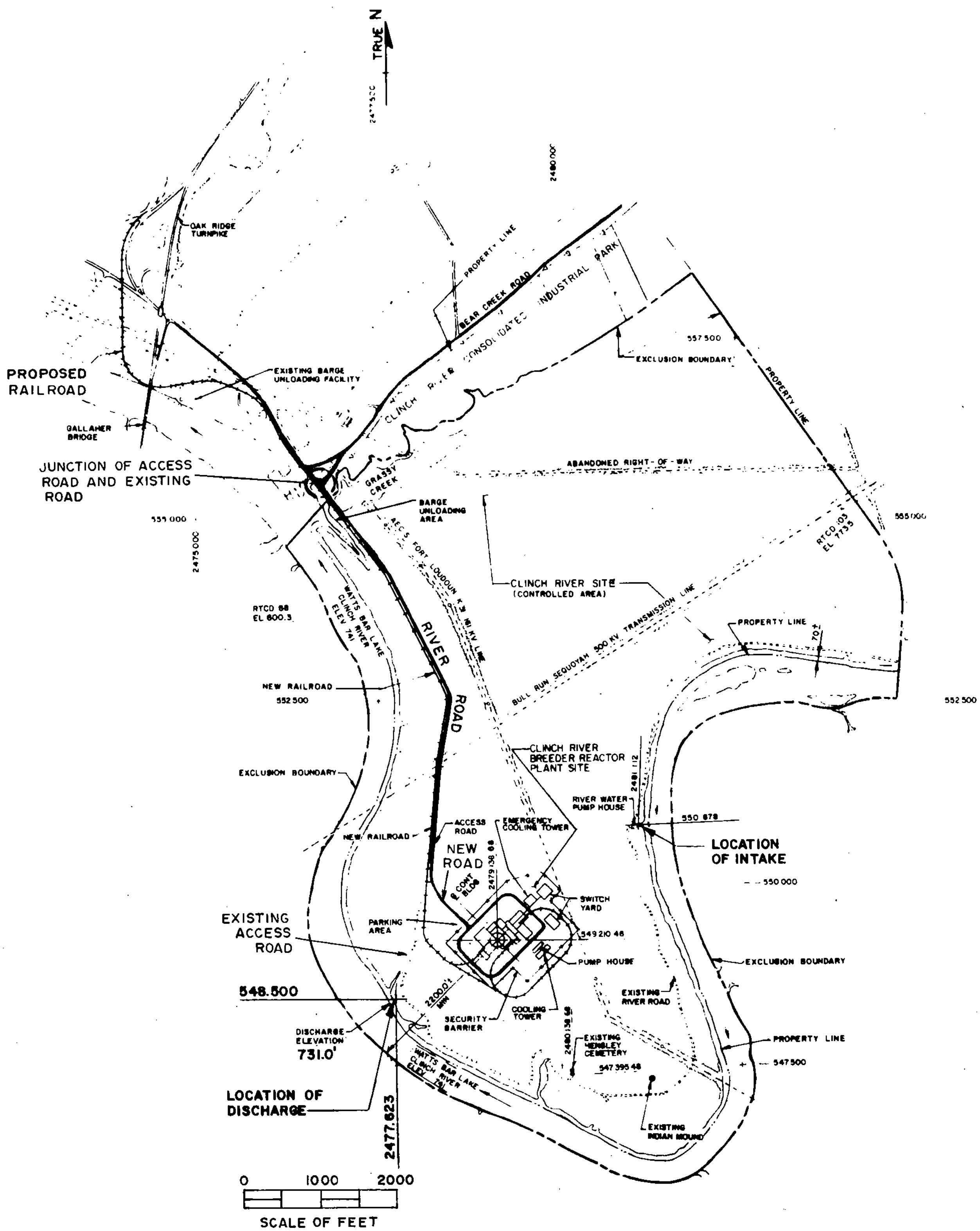
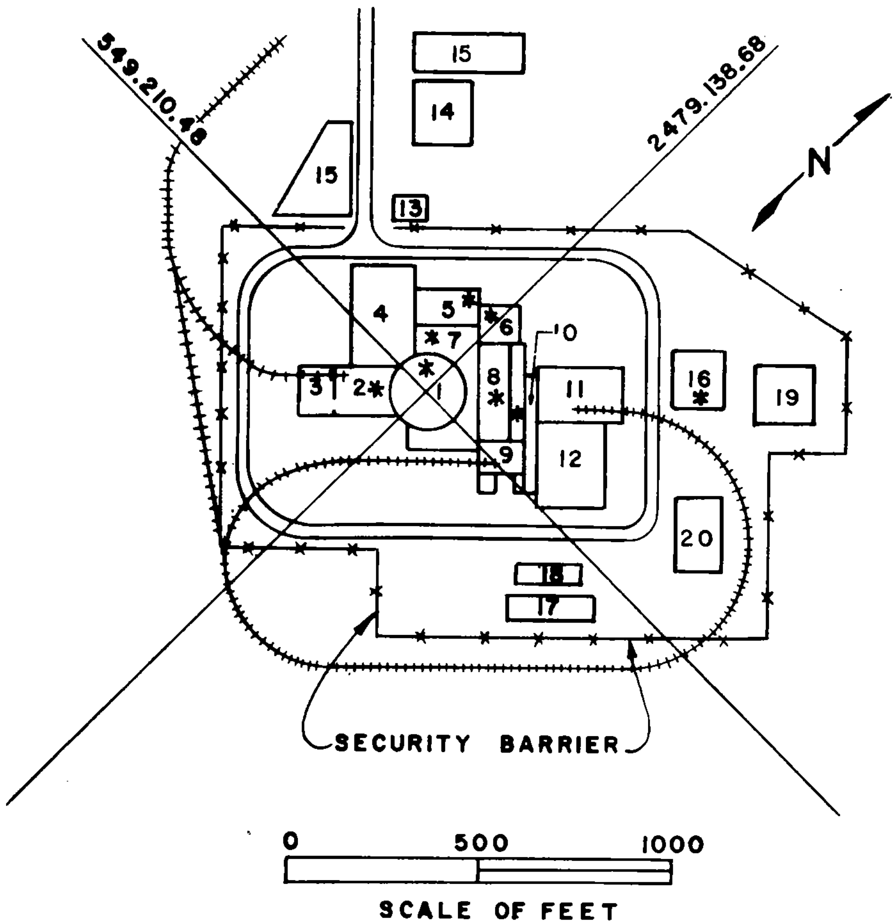


Figure 2.1-3 SITE LOCATION



1. REACTOR CONTAINMENT BUILDING
2. REACTOR SERVICE BUILDING
3. RADWASTE AREA
4. PLANT SERVICE BUILDING
5. CONTROL BUILDING
6. DIESEL GENERATOR BUILDING
7. INTERMEDIATE BAY
8. STEAM GENERATOR BUILDING
9. MAINTENANCE BAY
10. REACTION PRODUCTS SEPARATION EQUIPMENT BAY
11. TURBINE GENERATOR BUILDING
12. SHOPS AND WAREHOUSE
13. GATE HOUSE
14. TRAINING CENTER BUILDING
15. PARKING LOT
16. EMERGENCY COOLING TOWERS
17. COOLING TOWER
18. C.W. PUMP HOUSE
19. GENERATING YARD
20. START-UP YARD

* SAFETY-RELATED (CATEGORY I) STRUCTURES

Figure 2.1-4 ARRANGEMENT OF PLANT STRUCTURES

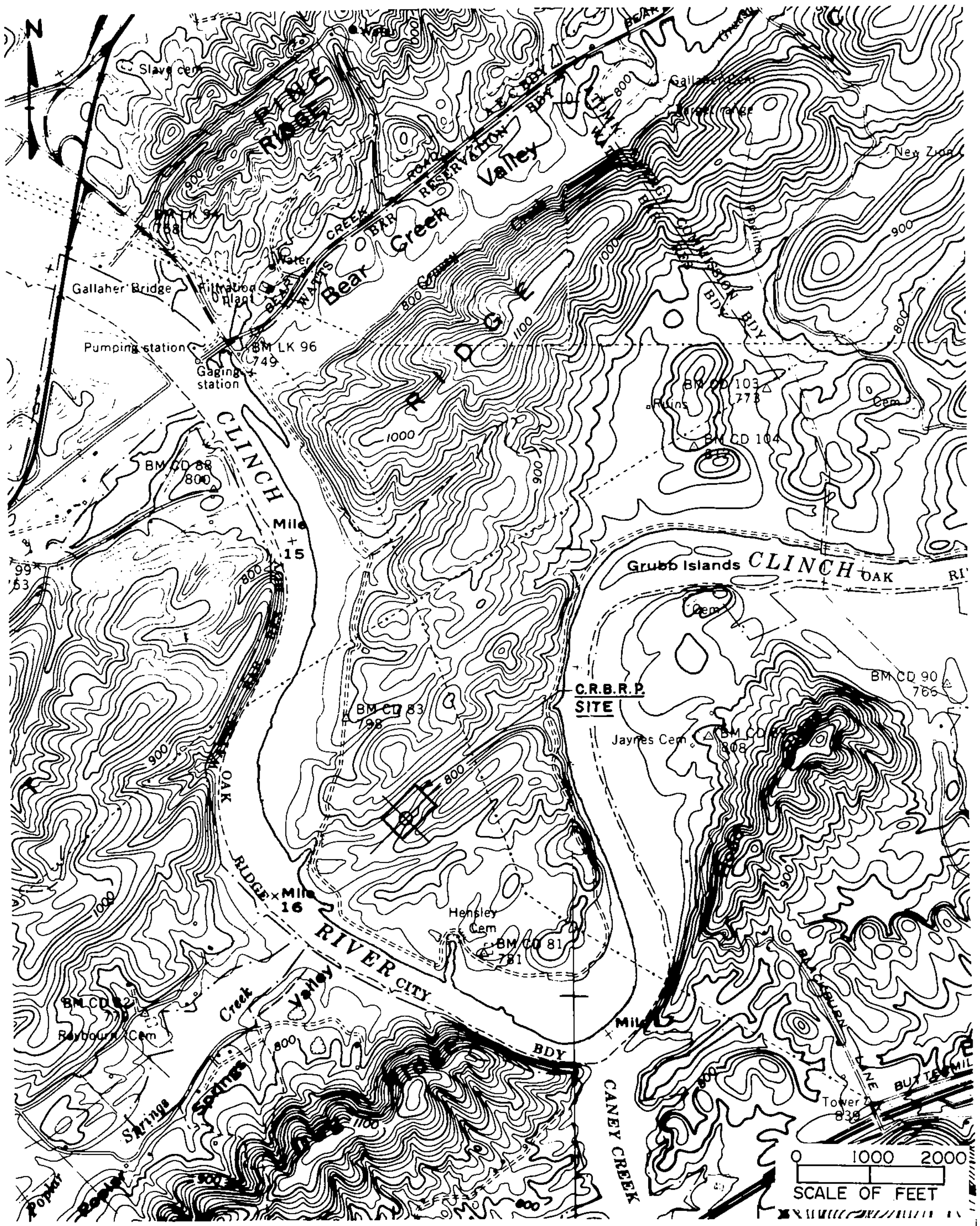


Figure 2.1-5 TOPOGRAPHY OF THE CRBRP SITE

Figure 2.1-6 AERIAL VIEW OF CLINCH RIVER SITE

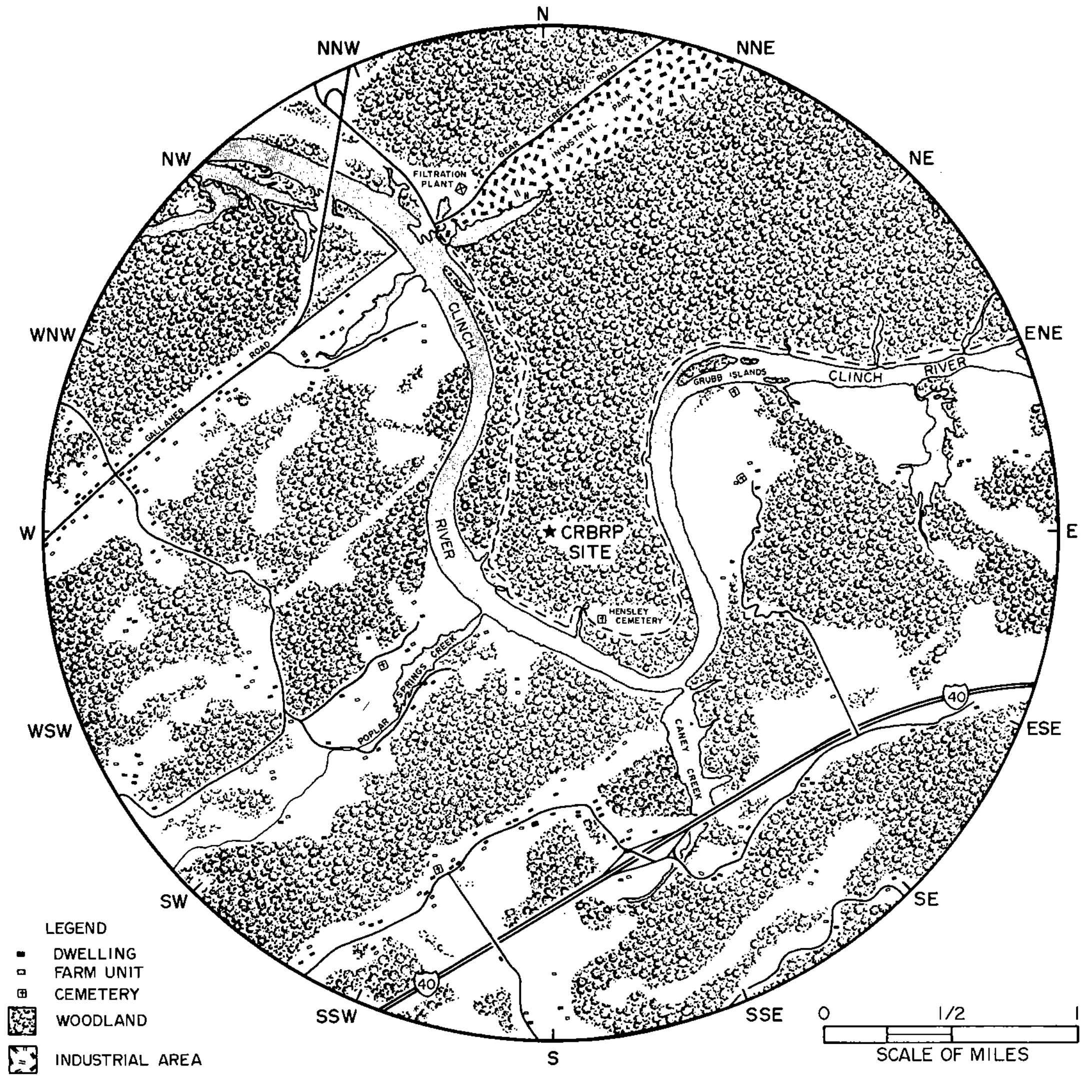


Figure 2.1-7 FARMS, DWELLINGS, INDUSTRIES AND WOODED AREAS WITHIN A 2-MILE RADIUS OF THE SITE

2.2 REGIONAL DEMOGRAPHY, LAND AND WATER USE

2.2.1 REGIONAL DEMOGRAPHY

Location and size of urban centers (population above 2,500) within a 50-mile radius of the plant site are shown in Table 2.2-1. There are only 21 such urban centers and two of these, Knoxville (1970 population of 174,587) and Oak Ridge (1970 population of 28,319), have populations exceeding 25,000. Twenty-seven urban centers with a 1970 population less than 2,500 within the 50-mile radius are listed in Table 2.2-2. The approximate center of the peninsular portion of the Site was used for demographic analysis, as shown in Figure 2.2-1.

Further discussion of the 1970 population distribution[1] and detailed breakdowns of the population into radial-azimuthal sectors within the 50-mile radius follows. A projection of this population distribution to the end of the expected 30-year operating life of the plant is provided and an assessment of the magnitude of the transient population is presented. Projected population figures used for the demographic analysis were baseline values published by the Tennessee Valley Authority, Division of Navigation Development and Regional Studies, Economic Research Staff in October 1972.[2] To make these values consistent with national, regional and OBE Economic Area Totals, sets of "first approximations" were developed by a Federal team which included economists from the Bureau of Economic Analysis, the Corps of Engineers, the Tennessee Valley Authority (TVA) and the Environmental Protection Agency (EPA). These approximations were then correlated with county baseline projections which were developed independently to represent local considerations in each county. The baseline value to be used for each county was reached by a consensus of the participants during work conferences. Distribution into the sectors required for this report was accomplished using local urban vs. rural growth patterns for defined census districts.

2.2.1.1 RESIDENT POPULATION WITHIN 10 MILES

The urban centers of Lenoir City, Kingston, Harriman and Oak Ridge are located within 10 miles of the CRBRP as shown in Figure 2.2-2. Figure 2.2-3 shows the comparative population distribution for the CRBRP area as compared to three other areas in which nuclear generating plants are presently operating.

A detailed analysis of the population distribution within the 10-mile radius was performed. For this purpose, the region surrounding the plant was divided into sixteen 22-1/2° azimuthal sectors with inner radial increments of 1, 2, 3, 4, 5 and 10 miles as illustrated in Figure 2.2-4. Results of this analysis, as presented in Table 2.2-3, show that the 1970 population out to 10 miles was 41,895, corresponding to an average population density in this area of 166 persons/square mile. The maximum population densities in the vicinity of the plant occur in the northeast sector which encompasses part of the city of Oak Ridge.

Within five miles of the plant site there are no significant population concentrations. Approximately one-third of this area comprises land owned by the U. S. Government and in the custody of AEC or TVA (including the Clinch River Site) and is within the city limits of Oak Ridge. Nevertheless, at least two-thirds of the resident population of Oak Ridge is located just beyond the 10-mile radius. This situation exists because of the unique way in which the city of Oak Ridge originated. In the 1940's, the Government acquired about 80,000 acres for a reservation to be used to develop weapons for World War II. One small part of this parcel of land was set aside for residential use and became known as the city of Oak Ridge. The remainder of the land was used for Government purposes. In the 1950's, the city of Oak Ridge became self-supporting and self-governing. At this time, the entire "Oak Ridge Reservation" (80,000 acres) was designated as the city of Oak Ridge though the major portion remained in the custody of AEC. The portion of the "city" available for residential development is limited because much of the land is reserved for Government use. Total population of the city was 28,319 in 1970.

Harriman, cut by the 10-mile radius to the west-northwest, contains 8,734 people. Two smaller towns located slightly closer to the Site are Lenoir City, about nine miles southeast of the Site, with 5,324 people and Kingston, about seven miles to the west, with a population of 4,142 in 1970.

Development trends and potential for the 10-mile area indicate that little change is expected within five miles of the Site during the lifetime of the CRBRP. The development patterns for the communities in the 5- to 10-mile range indicate that only Oak Ridge has the potential for growth in the direction of the Site. Long-range patterns for Oak Ridge (probably beyond 1990) could result in further concentrated development; however, this development will not occur within five miles of the plant site. As previously stated, the land to the north and east of the Site is government owned property in the custody of AEC. The AEC boundary is shown in Figure 2.2-5.

The 1960 and 1970 census data show that the rural population within 10 miles of the Site has tended to remain essentially constant. Population growth has taken place near the urban centers of Oak Ridge and Kingston. Projections for future population growth include the urban centers of Oak Ridge, Harriman, Lenoir City and Kingston.

Results of the analysis of the projected population distribution within 10 miles of the Site are shown in Tables 2.2-4 through 2.2-7 for the years 1980 through 2010. From these projections, it is seen that the population within 10 miles of the Site is expected to grow from its present level of 41,895 in 1970 to 65,089 in 2010.

2.2.1.2 RESIDENT POPULATION BETWEEN 5 AND 50 MILES

Most of the area within a 50-mile radius of the Site is within Tennessee. Only a small portion of North Carolina and a small portion of Kentucky are included. The total 1970 population of the 20 counties having five percent or more of their population within a 50-mile radius of the Site was 768,955. This was a population increase of only 5.9 percent over 1960 as compared with a population increase of 10 percent for Tennessee and 13 percent for the Nation. Population distribution within 50 miles of the CRBRP for census year 1970 is shown in Table 2.2-8. Projected population distribution within 50 miles for census years 1980, 1990, 2000 and 2010 are shown in Tables 2.2-9 through 2.2-12.

Figure 2.2-6 shows the location of urban centers within 50 miles of the Clinch River Site. One major urban center with a population of 50,000 or more is located within 50 miles of the Site. Knoxville, 21.5 miles to the east-northeast, had a 1970 population of 174,587. The Site is located within the city limits of Oak Ridge which had a 1970 population of 28,319. At least two-thirds of the resident population of Oak Ridge is located beyond the 10-mile radius.

In addition to Oak Ridge, two smaller population centers (population of 10,000 to 50,000) are within 50 miles of the Site. They are the Maryville-Alcoa-Eagleton Village area and Athens. The Maryville-Alcoa-Eagleton Village area is in the 20- and 30-mile range to the east-southeast of the Site and contains 26,892 people. Athens is in the 30- and 40-mile range to the south-southwest with a 1970 population of 11,790.

Numerous small communities and crossroads settlements are scattered throughout the region and are surrounded by low density rural development. Some of the communities may reach a population of 10,000 or more during the project life, but it is not anticipated that an additional metropolitan center will develop. Urban centers with a population less than 2,500 within a 50-mile radius for the census year 1970 are listed in Table 2.2-2. The trend in this area is toward dispersed growth in medium size communities rather than concentrated growth in a few major urban centers.[2] Zero population growth is expected within five miles of the Site during the life of the plant, as shown in Tables 2.2-3 through 2.2-7.

TVA is studying the possibility of developing Timberlake, a new town on the shores of the Tellico Reservoir which will be formed when construction of the Tellico Dam is completed. Population projections for Timberlake are 3,000 to 5,000 in 1980 and 12,000 to 18,000 in 1990. The range is dependent primarily on general economic conditions. This population should be allocated to the 10- and 20-mile south-southeast sector but is not included in the data in Tables 2.2-9 through 2.2-12 because of the tentative nature of the plans.

2.2.1.3 TRANSIENT POPULATION

An investigation was made of the various activities conducted within 10 miles of the Site to determine the magnitude of the transient population in the area. No major sport facilities or prisons exist within this region and the only components of the transient population that are significant involve school and industrial activities during weekdays, and recreational activities primarily over weekends and holidays.[3,4]

Most of the transient population near the Site is due to industrial activities in the area. In addition, some recreational activities occur which add to the transient population. Within a one-mile radius there is one sparsely used informal access and bank fishing area located at the end of a dirt road. There are two similar informal use areas in the one- to three-mile range. A 30-unit commercial camping and day use area is located about 2-3/4 miles southeast of the Site. The maximum number of people (at any one time) at this campsite is estimated to be

80 in 1980 and 100 in 1990. A 100-unit commercial camping site is under development on the Caney Creek embayment near Clinch River Mile (CRM) 17, slightly over one mile from the southeast boundary of the Site. Estimates of the maximum number of people at this campsite for 1980 and 1990 are 270 and 340 people, respectively. Activities at the campsite will include fishing, boating and swimming. A small stock-car racetrack, located about three miles southeast of the plant site, presently may attract 5,500 to 6,000 fans; this number could increase to 6,500 persons in 1990. The transient population within a five-mile radius of the Site is shown in Table 2.2-13.

Recreational areas within a 10-mile radius of the Site are shown in Figure 2.2-7. Table 2.2-14 shows the approximate mileage from the Site to each recreational area, the estimated number of persons who would be on each site during peak hour use and the type of site activity. Peak hour use was considered to occur on July 4 for each year. Projections for peak hours for the years 1980, 1990, 2000 and 2010 are included. Based on 1970 information, the peak hour recreational use of these facilities could result in 3,565 persons being present at one time within the 10-mile radius of the Site. This number could increase to 12,885 for the year 2010. Assuming that all these visitors reside outside the 10-mile radius from the Site, this would represent an increase of about eight percent over the permanent population of the area.

The number of recreational craft locked through the Melton Hill Dam, located about four and one-half miles southeast of the Site or six miles up the Clinch River, for each year from 1965 through 1972 are shown in Table 2.2-15. Total number of visitors to Melton Hill Dam in 1971 was 225,000; total number of visitors to the Dam since the project opened in 1963 was 2,596,000. Commercial freight traffic on the Clinch River is very sparse and has not exceeded 10,000 tons in any single year over the past seven years, as can be seen in Table 2.2-15.

2.2.1.4 PUBLIC FACILITIES AND INSTITUTIONS

Twenty-two schools located within a 10-mile radius of the Site, as shown in Figure 2.2-8, had a 1973 total enrollment of 7,901 students. Information on schools within the 10-mile radius is shown in Table 2.2-16. Oak Ridge anticipates building a new elementary school for their system by 1990. However, this school and other new schools to be built in the foreseeable future will replace those presently in use as they become obsolete. Other school systems included within the 10-mile radius do not forecast any significant expansion beyond that necessary to accommodate future educational requirements as shown in Table 2.2-16 as obsolete plants and facilities are retired or renovated.

According to the Journal of American Hospital Organization,[5] the nearest hospital to the Site is the Harriman City Hospital with 94 beds, located about 10 miles to the west-northwest. Oak Ridge Hospital of the Methodist Church, with 287 beds, is located about 15 miles to the northeast. Oak Ridge Associated Universities Medical Division Hospital, with 30 beds, is located about 15 miles to the northeast. A tabulation of additional hospital facilities and their respective capacities within 50 miles of the Site is shown in Table 2.2-17. No new hospitals are planned within the 10-mile radius in the foreseeable future. Two primary reasons for this are the scarcity of medical doctors at the local level and the proximity to the well equipped and staffed hospitals in nearby Knoxville.

Forecasts for public and private recreational areas were given in Section 2.2.1.3 and Table 2.2-14.

2.2.2 USES OF ADJACENT LANDS

Within a 10-mile radius of the Site, the region encompasses residential, farm, recreational and industrial areas. Land adjoining the Site is zoned F.A.I.R., suitable for forestry, agriculture, industry or residential use; the Site is zoned Industrial 2. No military installations exist in the area. Minimum exclusion area distance (10 CFR 100) is 2,200 feet for the CRBRP. Schools and hospitals, listed in Tables 2.2-16 and 2.2-17, respectively, are the only public facilities located within the 10-mile radius. No airports are located within the 10-mile radius of the Site; it is served primarily by a highway system. Industrial and recreational areas are listed in Section 2.2.2.2 and Section 2.2.1.3, respectively. Although the eastern Tennessee area is generally of a rural type with agriculture playing an important part, the area within the 10-mile radius has only five commercial dairy farms. There is no mineral production within the 10-mile radius; however, mineral production, primarily in the form of strip coal mining, does play an important role in the region, particularly in Morgan County. No wildlife preserves, sanctuaries or hunting areas are in the immediate vicinity of the Site. A waterfowl refuge which is part of the Long Island Wildlife Management Area is located on the Tennessee River approximately eight miles west-southwest of the Site.

2.2.2.1 AGRICULTURE

The majority of the region within the 10-mile radius lies within Roane County, touching only slightly in Morgan, Anderson, Knox and Loudon Counties. Checks with county agents have revealed that there are no commercial dairy farms located within the 10-mile radius in Morgan, Anderson or Knox Counties.[6] There are four commercial dairy farms in Roane County and one commercial dairy farm in Loudon County within 10 miles of the plant; these are shown in Figure 2.2-9 and tabulated in Table 2.2-18. During a survey conducted in the spring of 1974, approximately 475 head of beef cattle were counted within five miles of the Site. Scattered herds, ranging in size from 20 to 30 head were located in the southeast, southwest and northwest quadrants. Interspersed with the beef cattle were 61 milk cows. Agricultural crops within the 10-mile radius were reported as scattered small plots for single family use.

In general, farming in eastern Tennessee has followed the national trend of a steadily decreasing number of farms with the remaining farms increasing in average size.(7) Figure 2.2-10 is an illustration of this trend in the Emory River Valley and the county agents agree that this trend is valid in the local area. Because more off-farm employment opportunities exist now than in the past, the trend has been to shift from dairy cows and other forms of farming to raising beef cattle which requires less labor. As shown in Figure 2.2-11, the trend mentioned for the Emory River Valley shows that beef cattle production doubled from 1939 to 1964. The latest agricultural census, 1969, shows that this trend has accelerated and that beef cattle production has nearly doubled in the five-year period between 1964 and 1969. Although this trend is believed to apply to the general area, as indicated above, beef cattle in the local area are in small scattered herds. Also, according to the 1969 Census, the number of farms has decreased by 12 percent but there has been a 10 percent increase in the average size of farms.(8)

2.2.2.2 INDUSTRY

Three large industrial activities are located within five miles of the plant site, as shown in Figure 2.2-12. These are the Oak Ridge Gaseous Diffusion Plant about three miles north-northwest, the Oak Ridge National Laboratory about four miles northeast and TVA's Melton Hill Dam about four and one-half miles east.

Enriched uranium is produced at the Oak Ridge Gaseous Diffusion Plant (ORGDP). There are about 2,800 employees at ORGDP. Oak Ridge National Laboratory (ORNL) is a research and development facility which employs approximately 4,500 people. ORNL's work includes reactor and chemical technology, radiation effects, controlled fusion and other basic and applied research activities. Melton Hill Dam provides hydroelectric power to the TVA system and extends navigation up the Clinch River. A small crew attends the locks but the power unit operates unattended.

Three small industrial activities are located about one and one-half miles north of the center of the plant site in the Clinch River Consolidated Industrial Park as shown in Figure 2.2-13. U. S. Nuclear, Inc., has located a plant on a 10-acre parcel for the fabrication of neutron absorbers and fuel elements for test reactors with planned future production to include fuel elements for power reactors. They employ about 25 people and will expand to a maximum of about 50 people in the indeterminate future. Nuclear Environmental Engineering, Inc. has built a small plant on a five-acre tract for the calibration and resale of radioisotopes for use in education, research and industry. They will also manufacture radioisotope generators and radioactive tracers for oil fields or other uses. This plant started with a force of about 20 people and eventually will increase to a planned total of 75 people. Nuclear Assurance Corporation contains facilities to clean UF_6 containers. The recovered UF_6 will be returned to their customers. They employ about six people and will expand to a maximum of 45 people in about five years. All nuclear material handling by these three industries is done under controlled conditions in accordance with governing safety and health regulations.

Two additional industrial activities located in the area are AEC's Y-12 facility, nine miles northeast and TVA's Kingston Steam Plant, seven and one-half miles west of the plant site. The Y-12 facility provides production, research and development facilities for the Atomic Energy Commission and employs about 6,500 people. About 500 employees work at the Kingston Steam Plant which is a fossil-fired electrical generating plant with a capacity of 1,700,000 kilowatts. It is a major supplier of power to the Oak Ridge Gaseous Diffusion Plant.

2.2.2.3 MINERALS AND MINING

There is no mineral production within the 10-mile radius; however, mineral production does play an important role in the region,[9] particularly in Morgan County where strip mining for coal has been established for many years.

2.2.2.4 TRANSPORTATION

2.2.2.4.1 HIGHWAYS

One major highway, Interstate 40, passes approximately 1.25 miles south of the plant site as shown in Figure 2.2-14.[10] The closest interchanges on I-40 are State Routes 58 and 95, which are about four miles and three miles, respectively, from the plant site location. Average traffic count on I-40 between the exits for Routes 58 and 95 for a 24-hour period is 16,500.[11]

2.2.2.4.2 RAIL

Harriman Junction, approximately 10 miles northwest of the Site, has the closest major main rail line. It is served by both the Cincinnati, New Orleans & Texas Pacific (CNO & TP) and the Southern Railway.

2.2.2.4.3 WATER

Commercial traffic (tonnage) locked through Melton Hill Dam is shown in Table 2.2-15 for the years 1966 through 1972. Comparing the figures in the table, it appears that commercial traffic is increasing in tonnage but recreational traffic through the dam is decreasing in number.

2.2.2.4.4 AIR

Airports located near the Site are as follows:

Name	Type	Distance and Direction (miles)
Meadowlake Air Park	Sport	10 SW
Oak Ridge Air Park	Sport	11 NNE
Rockwood Municipal	Business/sport	18 W
McGhee-Tyson	Commercial	28 ESE

Of the four, only McGhee-Tyson (Knoxville) has scheduled commercial flights. V16, the nearest flight path, is about 10 miles south of the Site. As indicated in Figure 2.2-15, aircraft approaching McGhee-Tyson would be at a minimum altitude of 5,000 feet as they pass 10 miles south of the Site. The nearest holding pattern for McGhee-Tyson is approximately 30 miles northeast of the Site.

2.2.3 WATER USE

2.2.3.1 SURFACE WATER USE

Eight public water supplies withdrawing water from surface sources and two additional supplies with auxiliary intakes are located within a 20-mile radius of the Site. Three of these supplies are located where they could be influenced by the plant's waste discharges. The city of Rockwood, Tennessee, has an auxiliary public water supply intake location on the King Creek embayment of Watts Bar Reservoir where the potential for reverse flow exists. Under certain conditions, Clinch River water could flow upstream in the Emory River. Such flows carry residual radioisotopes and could possibly effect the Cumberland Utility District surface water intake and the Harriman water supply intake on the Emory River. Of the 16 industrial water supplies presently within a 20-mile radius of the Site, five are located where they could be influenced by water borne discharges from the CRBRP. The closest of these is located 1.6 miles downstream from the Site at CRM 14.4. This supply is used to provide potable water at the Oak Ridge Gaseous Diffusion Plant and the small industrial park at the north end of the Site property. An AEC supply at CRM 11.5 and TVA's Kingston Steam Plant supply could be influenced by discharges from the Site. Water supply for the Steam Plant is withdrawn from the Emory River, which could be influenced by flow coming down the Clinch River during certain periods of the summer. It is used for inplant purposes, including potable uses, as well as cooling. A. B. Long Quarries, Inc., and Mead Corporation are both located on the Emory River arm of Watts Bar Reservoir which could receive upstream flow from the Clinch River, but neither of these supplies is used for potable or sanitary purposes. Locations of industrial water supplies are shown in Figure 2.2-16 and additional information about the supplies is given in Table 2.2-19.

Within 50 miles downstream from the plant, two public water supplies can be influenced by water flowing past the Clinch River Site. Spring City, which is 30 miles from the Site and had a 1970 population of 1,756, withdraws 120,000 gallons of water per day from the Piney River. Piney River is influenced by backwater from Watts Bar Dam. The city of Dayton, 44 miles from the Site, withdraws 1,400,000 gallons of water per day from the Tennessee River. Dayton had a 1970 population of 4,361.

Clinch River water is not known to be used for irrigation in the vicinity of the Site. One farm, bordering the river in the southwest sector, has an auxiliary pumping system to supply water from the river to livestock during periods of low groundwater supply.

Treated effluent from the radwaste system will be mixed with the cooling tower blowdown prior to being discharged into the Clinch River. Since the first point of use of Clinch River water is about 1.6 miles downstream from the plant discharge, the minimum seasonal transit time is estimated to be 1.78 hours and the minimum seasonal dilution at the point of use is estimated to be 18.2 to 1. Data assumptions and models used in estimating transit time and dilution are provided in the Appendix to Section 10.3.

2.2.3.2 GROUNDWATER USE

Most of the development in the area has been rural residential and it has not been economically feasible to use public water supplies for every residence. Thus, many individual wells are found in the area. As described in Section 2.5, 110 wells and springs are located within two miles of the Site; however, all of these wells are located south of the Clinch River. The Clinch River bounds the Site groundwater system on three sides and is a groundwater sink for the system. Chestnut Ridge appears to represent the northern boundary for the groundwater system of the entire peninsula as can be seen in Figure 2.5-1. Discharge from the aquifer system goes directly into the river or into streams which flow into the river. Because the incised meander of the river is a major topographic feature set down in bedrock,[12] it is unlikely that any groundwater flow could pass beneath the river.

Within a 20-mile radius of the Site there are 17 public water supplies withdrawing water from wells and springs. These are listed in Table 2.2-20 which also includes public water supplies drawn from surface water. Locations of those within 10 miles of the Site are shown on Figure 2.2-17.

TABLE 2.2-1

URBAN CENTERS WITH POPULATION >2500
WITHIN A 50-MILE RADIUS OF THE CRBRP
FOR CENSUS YEAR 1970

Urban Center	County	Distance* From Plant (miles)	Approx. Direction	Population
Knoxville	Knox	21.50	ENE	174,587
Oak Ridge	Anderson-Roane	9.00	NE	28,319
Maryville	Blount	25.00	ESE	13,808
Athens	McMinn	32.75	SSW	11,790
Harriman	Roane	9.50	WNW	8,734
Alcoa	Blount	23.50	ESE	7,739
La Follette	Campbell	36.50	NNE	6,902
Crossville	Cumberland	36.50	W	5,381
Lenoir City	Loudon	8.75	SE	5,324
Rockwood	Roane	16.00	W	5,259
Eagleton Village	Blount	25.25	ESE	5,345
Clinton	Anderson	20.50	NE	4,794
Dayton	Rhea	44.50	SW	4,361
Sweetwater	Monroe	20.00	SSW	4,340
Kingston	Roane	7.00	W	4,142
Etowah	McMinn	39.25	SSW	3,736
Loudon	Loudon	10.50	SSE	3,728
Oliver Springs	Anderson Morgan Roane	10.75	NNE	3,405
Sevierville	Sevier	45.50	E	2,661
Madisonville	Monroe	25.25	S	2,614
Oneida	Scott	42.50	N	2,602

*Distances measured from the edge of the residential areas nearest the Site

TABLE 2.2-2

URBAN AREAS WITH POPULATION <2500
WITHIN A 50-MILE RADIUS OF THE CRBRP
FOR CENSUS YEAR 1970

Urban Center	County	Distance* From Plant (miles)	Approx. Direction	Population
Lake City	Anderson	25.75	NNE	1,923
Norris	Anderson	27.25	NE	1,359
Pikeville	Bledsoe	49.50	WSW	1,454
Friendsville	Blount	16.75	ESE	575
Townsend	Blount	38.25	ESE	267
Charleston	Bradley	46.75	SSW	792
Caryville	Campbell	29.75	NNE	648
Jacksboro	Campbell	32.25	NNE	689
Pleasant Hill	Cumberland	46.00	W	293
Allardt	Fentress	43.75	NW	610
Jamestown	Fentress	48.00	NW	1,899
Greenback	Loudon	19.75	SE	318
Philadelphia	Loudon	14.75	S	554
Calhoun	McMinn	46.50	SSW	624
Englewood	McMinn	32.75	S	1,878
Niota	McMinn	27.75	SSW	629
Decatur	Meigs	34.75	SW	698
Tellico Plains	Monroe	36.75	S	773
Vonore	Monroe	22.25	SSE	524
Oakdale	Morgan	11.75	WNW	376
Wartburg	Morgan	19.00	NW	541

(Continued)

TABLE 2.2-2 (Continued)

Urban Center	County	Distance* From Plant (miles)	Approx. Direction	Population
Spring City	Rhea	29.75	WSW	1,756
Huntsville	Scott	36.25	N	337
Gatlinburg	Sevier	49.50	ESE	2,329
Pigeon Forge	Sevier	45.50	E	1,361
Luttrell	Union	41.75	ENE	819
Maynardville	Union	40.75	NE	702

*Distances measured to edge of residential area nearest the Site

TABLE 2.2-3

POPULATION DISTRIBUTION
WITHIN 10 MILES OF THE CRBRP
FOR CENSUS YEAR 1970*

Sector Designation	Radial Interval (miles) 0-1	1-2	2-3	3-4	4-5	5-10
N	0	0	0	0	0	1,375
NNE	0	0	0	0	0	7,850
NE	0	0	0	0	0	1,680
ENE	5	5	0	0	0	185
E	10	5	30	30	10	940
ESE	5	5	15	65	115	1,895
SE	0	15	45	95	115	8,700
SSE	0	15	20	120	125	955
S	5	35	20	75	95	335
SSW	0	35	5	70	65	175
SW	5	25	30	100	75	305
WSW	0	30	70	115	250	2,950
W	0	55	165	105	75	3,760
WNW	0	60	100	30	55	5,545
NW	0	20	0	0	45	1,270
NNW	0	0	0	0	75	1,235
Sum for Radial Interval	30	305	500	805	1,100	39,155
Accumulative Total up to Radius Indicated	30	335	835	1,640	2,740	41,895
Average Density (people/mi^2) in Radial Region	10	32	32	37	39	166

*Based on information prepared by TVA Division of Navigational Development and Regional Studies, Economic Research

TABLE 2.2-4

PROJECTED POPULATION DISTRIBUTION
WITHIN 10 MILES OF THE CRBRP
FOR CENSUS YEAR 1980

Sector Designation	Radial Interval (miles) 0-1	1-2	2-3	3-4	4-5	5-10
N	0	0	0	0	0	1,375
NNE	0	0	0	0	0	6,261
NE	0	0	0	0	0	7,850
ENE	5	5	0	0	0	185
E	10	5	30	30	10	940
ESE	5	5	15	65	115	1,895
SE	0	15	45	95	115	9,605
SSE	0	15	20	120	125	955
S	5	35	20	75	95	335
SSW	0	35	5	70	65	175
SW	5	25	30	100	75	305
WSW	0	30	70	115	250	2,950
W	0	55	165	105	75	4,360
WNW	0	60	100	30	55	7,111
NW	0	20	0	0	45	1,270
NNW	0	0	0	0	75	1,235
Sum for Radial Interval	30	305	500	805	1,100	46,807
Accumulative Total up to Radius Indicated	30	335	835	1,640	2,740	49,547
Average Density (people/mi^2) in Radial Region	10	32	32	37	39	199

TABLE 2.2-5

PROJECTED POPULATION DISTRIBUTION
WITHIN 10 MILES OF THE CRBRP
FOR CENSUS YEAR 1990

Sector Designation	Radial Interval (miles) 0-1	1-2	2-3	3-4	4-5	5-10
N	0	0	0	0	0	1,513
NNE	0	0	0	0	0	7,200
NE	0	0	0	0	0	9,027
ENE	5	5	0	0	0	203
E	10	5	30	30	10	1,034
ESE	5	5	15	65	115	2,122
SE	0	15	45	95	115	10,950
SSE	0	15	20	120	125	1,003
S	5	35	20	75	95	342
SSW	0	35	5	70	65	184
SW	5	25	30	100	75	342
WSW	0	30	70	115	250	2,950
W	0	55	165	105	75	4,796
WNW	0	60	100	30	55	7,822
NW	0	20	0	0	45	1,397
NNW	0	0	0	0	75	1,358
Sum for Radial Interval	30	305	500	805	1,100	52,243
Accumulative Total up to Radius Indicated	30	335	835	1,640	2,740	54,983
Average Density (people/mi2) in Radial Region	10	32	32	37	39	222

TABLE 2.2-6

PROJECTED POPULATION DISTRIBUTION
WITHIN 10 MILES OF THE CRBRP
FOR CENSUS YEAR 2000

Sector Designation	Radial Interval (miles) 0-1	1-2	2-3	3-4	4-5	5-10
N	0	0	0	0	0	1,664
NNE	0	0	0	0	0	8,064
NE	0	0	0	0	0	9,929
ENE	5	5	0	0	0	213
E	10	5	30	30	10	1,054
ESE	5	5	15	75	115	2,334
SE	0	15	45	95	115	12,483
SSE	0	15	20	120	125	1,053
S	5	35	20	75	95	345
SSW	0	35	5	70	65	185
SW	5	25	30	100	75	345
WSW	0	30	70	115	250	3,216
W	0	55	165	105	75	5,276
WNW	0	60	100	30	55	8,604
NW	0	20	0	0	45	1,537
NNW	0	0	0	0	75	1,494
Sum for Radial Interval	30	305	500	805	1,100	57,796
Accumulative Total up to Radius Indicated	30	335	835	1,640	2,740	60,536
Average Density (people/mi2) in Radial Region	10	32	32	37	39	245

TABLE 2.2-7

PROJECTED POPULATION DISTRIBUTION
WITHIN 10 MILES OF THE CRBRP
FOR CENSUS YEAR 2010

Sector Designation	Radial Interval (miles)					
	0-1	1-2	2-3	3-4	4-5	5-10
N	0	0	0	0	0	1,830
NNE	0	0	0	0	0	8,870
NE	0	0	0	0	0	10,921
ENE	5	5	0	0	0	224
E	10	5	30	30	10	1,107
ESE	5	5	15	65	115	2,521
SE	0	15	45	95	115	14,231
SSE	0	15	20	120	125	1,085
S	5	35	20	75	95	352
SSW	0	35	5	70	65	187
SW	5	25	30	100	75	376
WSW	0	30	70	115	250	3,377
W	0	55	165	105	75	5,487
WNW	0	60	100	30	55	8,690
NW	0	20	0	0	45	1,552
NNW	0	0	0	0	75	1,539
Sum for Radial Interval	30	305	500	805	1,100	62,349
Accumulative Total up to Radius Indicated	30	335	835	1,640	2,740	65,089
Average Density (people/mi^2) in Radial Region	10	32	32	37	39	265

TABLE 2.2-8

POPULATION DISTRIBUTION
WITHIN 50 MILES OF THE CRBRP
FOR CENSUS YEAR 1970*

Sector Designation	Radial Interval (miles) 0-5	5-10	10-20	20-30	30-40	40-50
N	0	1,375	2,000	705	3,085	6,480
NNE	0	7,850	5,845	8,515	13,575	8,160
NE	0	1,680	26,955	13,110	4,675	5,665
ENE	10	185	13,450	129,165	31,395	9,875
E	85	940	21,520	74,020	15,025	15,345
ESE	205	1,895	3,890	42,620	4,325	1,700
SE	270	8,700	2,220	6,280	270	1,315
SSE	280	955	4,385	3,045	995	1,450
S	230	335	4,590	8,475	7,355	2,580
SSW	175	175	1,725	8,255	20,045	10,480
SW	235	305	1,285	1,980	5,260	9,590
WSW	465	2,950	1,890	2,670	3,375	3,995
W	400	3,760	11,135	2,365	9,290	3,910
WNW	245	5,545	3,965	230	3,290	3,915
NW	65	1,270	2,730	2,490	2,205	6,365
NNW	75	1,235	3,035	905	4,235	2,230
Sum for Radial Interval	2,740	39,155	110,620	304,830	128,400	93,055
Accumulative Total up to Radius Indicated	2,740	41,895	152,515	457,345	585,745	678,800
Average Density (people/mi^2) in Radial Region	35	167	117	194	58	33

*Based on information prepared by TVA Division of Navigational Development and Regional Studies, Economic Research

TABLE 2.2-9

PROJECTED POPULATION DISTRIBUTION
WITHIN 50 MILES OF THE CRBRP
FOR CENSUS YEAR 1980

Sector Designation	Radial Interval (miles) 0-5	5-10	10-20	20-30	30-40	40-50
N	0	1,375	2,325	685	3,580	7,060
NNE	0	7,850	6,430	8,260	16,190	8,405
NE	0	6,261	31,045	13,240	4,815	6,685
ENE	10	185	16,140	142,085	34,220	10,860
E	85	940	23,670	77,720	16,660	17,215
ESE	205	1,895	4,160	48,585	5,840	2,040
SE	270	9,605	2,310	6,405	275	1,320
SSE	280	955	4,520	3,555	995	1,450
S	230	335	4,680	10,170	7,500	2,570
SSW	175	175	1,760	8,585	24,055	12,365
SW	235	305	1,415	1,980	5,680	10,455
WSW	465	2,950	2,080	2,670	3,645	4,195
W	400	4,360	12,360	2,365	10,310	4,300
WNW	245	7,111	4,480	230	3,290	4,070
NW	65	1,270	3,000	2,490	2,205	6,430
NNW	75	1,235	3,035	905	4,235	2,230
Sum for Radial Interval	2,740	46,807	123,410	329,930	143,495	101,650
Accumulative Total up to Radius Indicated	2,740	49,547	172,957	502,887	646,382	748,032
Average Density (people/mi^2) in Radial Region	35	199	130	210	65	36

TABLE 2.2-10

PROJECTED POPULATION DISTRIBUTION
WITHIN 50 MILES OF THE CRBRP
FOR CENSUS YEAR 1990

Sector Designation	Radial Interval (miles) 0-5	5-10	10-20	20-30	30-40	40-50
N	0	1,513	2,560	685	4,010	7,835
NNE	0	9,027	7,075	8,010	17,650	8,660
NE	0	7,200	36,635	13,900	5,250	8,890
ENE	10	203	19,365	156,295	37,640	12,270
E	85	1,034	26,040	81,605	18,325	19,280
ESE	205	2,122	4,410	56,360	7,185	2,365
SE	270	10,950	2,400	6,660	280	1,325
SSE	280	1,003	4,655	3,730	1,000	1,450
S	230	342	4,775	11,190	7,650	2,560
SSW	175	184	1,795	9,015	26,220	14,345
SW	235	342	1,585	1,985	6,360	12,130
WSW	465	2,950	2,290	2,750	3,940	4,320
W	400	4,796	13,595	2,365	11,240	4,685
WNW	245	7,822	5,065	230	3,290	4,190
NW	65	1,397	3,300	2,490	2,205	6,625
NNW	75	1,358	3,035	900	4,235	2,230
Sum for Radial Interval	2,740	52,243	138,580	358,170	156,480	113,160
Accumulative Total up to Radius Indicated	2,740	54,983	193,563	551,733	708,213	821,373
Average Density (people/mi^2) in Radial Region	35	222	147	227	71	40

TABLE 2.2-11

PROJECTED POPULATION DISTRIBUTION
WITHIN 50 MILES OF THE CRBRP
FOR CENSUS YEAR 2000

Sector Designation	Radial Interval (miles) 0-5	5-10	10-20	20-30	30-40	40-50
N	0	1,664	2,815	685	4,450	8,620
NNE	0	9,929	7,780	7,770	18,355	8,915
NE	0	8,064	42,860	14,595	5,615	11,650
ENE	10	213	23,240	171,920	41,030	13,255
E	85	1,054	28,640	85,685	20,160	21,600
ESE	205	2,334	4,630	64,810	8,190	2,815
SE	270	12,483	2,500	6,930	280	1,330
SSE	280	1,053	4,795	3,955	1,000	1,450
S	230	345	4,870	12,530	7,650	2,550
SSW	175	185	1,830	9,085	30,940	16,350
SW	235	345	1,710	1,985	6,360	13,220
WSW	465	3,216	2,515	2,805	4,290	4,535
W	400	5,276	14,820	2,365	12,135	5,205
WNW	245	8,604	5,465	225	3,290	4,275
NW	65	1,537	3,630	2,490	2,205	6,690
NNW	75	1,494	3,035	900	4,235	2,230
Sum for Radial Interval	2,740	57,796	155,135	388,735	170,185	124,690
Accumulative Total up to Radius Indicated	2,740	60,536	215,671	604,406	774,591	899,281
Average Density (people/mi^2) in Radial Region	35	245	161	247	77	44

TABLE 2.2-12

PROJECTED POPULATION DISTRIBUTION
WITHIN 50 MILES OF THE CRBRP
FOR CENSUS YEAR 2010

Sector Designation	Radial Interval (miles) 0-5	5-10	10-20	20-30	30-40	40-50
N	0	1,830	3,095	685	4,980	9,570
NNE	0	10,921	8,560	7,690	19,275	9,185
NE	0	8,870	50,575	15,180	5,955	14,560
ENE	10	224	27,890	189,115	45,135	14,180
E	85	1,107	31,505	89,970	22,175	24,190
ESE	205	2,521	4,860	73,885	9,335	3,295
SE	270	14,231	2,600	7,205	290	1,330
SSE	280	1,085	4,940	4,235	1,005	1,450
S	230	352	4,970	14,160	7,805	2,540
SSW	175	187	1,870	9,720	37,130	18,315
SW	235	376	1,915	1,990	6,490	14,410
WSW	465	3,377	2,770	2,890	4,465	4,675
W	400	5,487	16,595	2,460	13,470	5,720
WNW	245	8,690	6,015	225	3,290	4,360
NW	65	1,552	4,065	2,490	2,205	6,825
NNW	75	1,539	3,035	990	4,235	2,230
Sum for Radial Interval	2,740	62,349	175,260	422,890	187,240	136,835
Accumulative Total up to Radius Indicated	2,740	65,089	240,349	663,239	850,479	987,314
Average Density (people/mi^2) in Radial Region	35	265	186	269	85	48

TABLE 2.2-13

TRANSIENT POPULATION
WITHIN 5-MILE RADIUS OF THE CRBRP

Distance (miles)	Activity	Daily Transients
1.0	Recreation Area	40
1.5	U.S. Nuclear, Inc.	25
1.5	Nuclear Environmental Engineering, Inc.	20
1.5	Nuclear Assurance Company	6
2.0	Recreation Area	70
3.0	Recreation Areas (6)	1,360
3.0	Oak Ridge Gaseous Diffusion Plant	2,800
3.5	Edgewood Elementary School	135
4.0	Oak Ridge National Laboratory	4,500
4.5	Melton Hill Dam (TVA)	6
5.0	Recreation Areas (5)	210

TABLE 2.2-14

ESTIMATED AVERAGE PEAK HOUR USE AT RECREATION AREAS WITHIN 10 MILES OF THE CRBRP*

Mileage Zone	Site No.**	Est. No. Persons Present During Peak Hour 1970	1980	1990	2000	2010
1	1	40	55	70	80	90
2	2	70	95	115	130	145
3	2a+	15	20	25	30	30
	2b+	60	80	100	110	120
	2c+	1,000	6,000	6,500	7,000	7,300
	2d	200	270	340	380	420
	3	15	20	25	30	30
	4	70	95	115	130	145
4	None					
5	4a+	15	20	25	30	30
	5	70	95	115	130	145
	6	15	20	25	30	30
	7	70	95	115	130	145
	8	40	55	70	80	90
6	9	25	35	45	50	55
	10	40	55	70	80	90
	11	15	20	25	30	30
7	12	40	55	70	80	90
	13	40	55	70	80	90
	13a	20	25	35	40	40
	13b+	100	135	170	190	210
	14	15	20	25	30	30
	15	40	55	70	80	90
	16	70	95	115	130	145
	17	40	55	70	80	90
	18	40	55	70	80	90
8	19	40	55	70	80	90
	20	20	25	30	35	40
	21	40	55	70	80	90
	22	40	55	70	80	90
	23	70	95	115	130	145

(Continued)

TABLE 2.2-14 (Continued)

Mileage Zone	Site No.**	Est. No. Persons Present During Peak Hour 1970	1980	1990	2000	2010
8	24	40	55	70	80	90
	25	70	95	115	130	160
	25a+	15	15	20	25	30
	26	15	20	25	30	35
	27	40	55	70	80	95
	28	40	55	70	80	95
	29	30	45	55	60	75
	30	20	25	35	40	45
	31	70	95	115	130	160
	31a+	55	75	90	105	125
	32	15	20	25	30	35
	33	70	95	115	130	160
	34	15	20	25	30	35
9	35	25	35	45	50	60
	36	40	55	70	80	95
	37	15	20	25	30	35
	38	70	95	120	150	165
	39	70	95	115	145	160
	40	70	95	115	145	160
10	41	25	35	45	50	55
	42	15	20	25	30	30
	42a+	55	75	90	105	115
	43	70	95	115	130	145
	44	40	55	70	80	90
	45	70	95	115	130	145
	46	20	25	30	35	40
	47	15	20	25	30	30
	48	30	40	50	55	60
	49	20	25	35	40	40
	50	15	20	25	25	30
	51	30	45	55	60	65
Total	61	3,565	9,480	10,830	11,965	12,885

*Information supplied by TVA, Special Studies Section, Recreation Resources Branch

**Keyed to Figure 2.2-7

+Activities at the sites are: 2a, ORGDP overlook; 2b, commercial trout pond; 2c, stockcar track; 4a, Graphite reactor; 13b, wildlife observation; 25a, 31a and 42a, golf. All other sites consist of improved and unimproved day-camp sites, most with boat launching ramps.

TABLE 2.2-15

TRAFFIC LOCKED THROUGH MELTON HILL DAM

Year	Recreational Craft (number)*	Commercial Traffic (tonnage)**
1966	1,198	1,000
1967	1,014	1,000
1968	1,256	2,000
1969	1,301	1,000
1970	929	4,000
1971	718	10,000
1972	761	3,600

*Information supplied by TVA Division of Navigational Development and Regional Studies, Navigation Economics Branch

**Information supplied by the U.S. Corps of Engineers

TABLE 2.2-16

INFORMATION ON SCHOOLS WITHIN 10-MILE RADIUS OF CRBRP

School System	Forecast
Anderson County	No schools are within 10 miles of Site and none forecast for 1980 or 1990.
Oak Ridge	No schools are within 10 miles of Site. A new elementary school (K-6) is likely by 1990 in western Oak Ridge to accommodate 725 students.
Knox County	No schools are within 10 miles of Site and none forecast for 1980 or 1990.

School System	No.	School	Grades	1971	1980	1990	Distance in Miles and Direction From Site
Loudon County	1	Browder	1-8	111	200	250	9.0 SSE
	2	Eatons	K-8	638	800	850	5.5 SE
	3	Highland Park	K-8	380	600	700	9.5 SE
Lenoir City	4	Lenoir City High School	9-12	910	950	1,000	8.0 SE
	5	Lenoir City Junior High School	5-8	472	700	800	9.5 SE
	6	Nichols School	K-4	401	750	800	9.0 SE
	7	West Hill	1-6	113	250	300	8.5 SE
Morgan County	8	Coalfield Elementary	1-8	375	375	375	10.0 NNW
	9	Coalfield High School	9-12	183	200	200	10.0 NNW
Roane County	10	Edgewood	1-6	110	200	200	3.5 WSW
	11	Cherokee	1-6	294	500	600	7.0 NNW
	12	Dyllis	1-8	211	300	300	5.5 NNW
	13	Emory	1-8	118	200	300	7.5 NW
	14	Fairview	K-6	200	200	250	9.0 W
	15	Kingston Elementary	K-6	675	750	900	7.5 WSW
	16	Kingston Junior High School	7-8	351	500	600	8.0 W
	17	Roane County High School	9-12	814	1,000	1,200	7.5 W
Harriman	18	Cumberland Junior High School	7-9	345	600	650	9.5 WNW
	19	Harriman Central Elementary	1-6	362	600	700	9.5 WNW
	20	Harriman High School	10-12	504	850	900	9.5 WNW
	21	Margrave	5-6	109	125	125	10.0 WNW
	22	Walnut Hill	1-4	225	500	500	10.0 WNW
Oak Ridge	23	New Elementary	K-6	-	-	725	9.0 NNE

TABLE 2.2-17

HOSPITALS WITHIN 50 MILES OF SITE

Hospital	City	County	No. of Beds	No. of Bassinets	Distance in miles and Direction from Site	
Little Creek Sanitarium and Hospital	Concord	Knox	25	--	21.5	ENE
Cumberland Medical Center	Crossville	Cumberland	82	11	36.5	W
Rhea County Hospital	Dayton	Rhea	45	8	44.5	SW
Woods Memorial Hospital	Etowah	McMinn	34	10	39.25	SSW
Harriman City Hospital	Harriman	Roane	94	12	9.5	WNW
Fentress County General	Jamestown	Fentress	70	8	48.0	NW
Christenberry Infirmary	Knoxville	Knox	12	--	21.5	ENE
Eastern State Psychiatric	Knoxville	Knox	2,761	--	21.5	ENE
East Tennessee Baptist	Knoxville	Knox	349	38	21.5	ENE
East Tennessee Chest Disease Hospital	Knoxville	Knox	180	4	21.5	ENE
East Tennessee Children's	Knoxville	Knox	52	--	21.5	ENE
Fort Sanders Presbyterian	Knoxville	Knox	374	40	21.5	ENE
Knoxville Osteopathic	Knoxville	Knox	25	6	21.5	ENE
Parkwest	Knoxville	Knox	200	25	21.0	ENE
St. Mary's Memorial Hospital	Knoxville	Knox	425	30	21.5	ENE
Serene Manor Hospital	Knoxville	Knox	68	--	21.5	ENE
University of Tennessee Memorial Research Center and Hospital	Knoxville	Knox	336	34	21.5	ENE
LaFollette Community	LaFollette	Campbell	76	11	36.5	NNE
Charles H. Bacon Hospital	Loudon	Loudon	47	18	10.5	SSE
Blount Memorial Hospital	Maryville	Blount	230	30	25.0	ESE
Oak Ridge Associated Universities Medical Div.	Oak Ridge	Anderson	30	--	15.0	NE
Oak Ridge Hospital of Methodist Church	Oak Ridge	Anderson	287	20	15.0	NE
Chamberlain Memorial	Rockwood	Roane	55	10	16.0	W
Sevier County Hospital	Sevierville	Sevier	48	12	45.5	E

TABLE 2.2-18

COMMERCIAL DAIRY HERDS WITHIN 10 MILES OF CRBRP

	Type	Livestock Population	Distance from Site (miles)	Direction
1.	Dairy	45	4.0	W
2.	Dairy	50	4.5	W
3.	Dairy	50	5.5	W
4.	Dairy	65	9.5	ESE
5.	Dairy	90	10.0	WNW

TABLE 2.2-19

INDUSTRIAL WATER SUPPLIES WITHIN A 20-MILE RADIUS OF CRBRP

	Supply	Approx. Radial Distance From Site (miles)	Average Daily Use (gallons)	Source
1.	Atomic Energy Commission	1.6	2,500,000	Surface (Clinch River Mile 14.4)*
2.	Atomic Energy Commission	3.5	5,500,000	Surface (Clinch River Mile 11.5)**
3.	TVA Kingston Steam Plant	7.8	1,400,000,000	Surface (Emory River Mile 1.9)+
4.	Lenoir City Car Works	9.3	30,000	Ground, Well+
5.	The Mead Corp.	9.7	2,900,000	Surface (Emory River Mile 11.4)
6.	Charles H. Bacon, Co.	9.8	255,000	Ground, Well+
7.	Union Carbide	10.2	2,000,000	Surface (Tennessee River) and Ground, Spring+
8.	Charles H. Bacon, Co.	10.2	300,000	Surface (Tennessee River) and Ground, Spring+
9.	Atomic Energy Commission	11.0	22,000,000	Surface (Clinch River Mile 41.5)++
10.	Ralph Rogers Co., Inc.	11.4	24,000	Ground, Well
11.	CNO & TP Railway	12.6	27,000	Surface (Emory River Mile 18.8)+
12.	A. B. Long Quarries	13.4	1,500,000	Surface (Emory River)

(Continued)

TABLE 2.2-19 (Continued)

	Supply	Approx. Radial Distance From Site (miles)	Average Daily Use (gallons)	Source
13.	John J. Craig Co.	13.8	34,600	Surface (Small Stream) and Ground, Well
14.	Philadelphia Hosiery Mills	14.5	20,000	Ground, Well
15.	TVA Bull Run Steam Plant	15.3	572,000,000	Surface (Clinch River Mile 47.6)+
16.	Morgan Apparel Co.	17.8	3,000	Ground, Well

*Potable water only

**Daily makeup for ORGDP cooling towers

+Water supply is also used for potable water within the plant

++Supplies 3,500,000 gallons per day to city of Oak Ridge (pop. 28,319)

TABLE 2.2-20

PUBLIC WATER SUPPLIES WITHIN 20-MILE RADIUS OF CRBRP

	Supply	Approx. Radial Distance from Site (miles)	Population Served	Average Daily Use (gallons)	Source
1.	Edgewood Elementary School	3.5	196	4,900	Ground, Well
2.	Cumberland Utility District of Roane and Morgan Co.	6.7	5,000	212,000	Ground, Spring*
3.	Dixie Lee Utility District	8.6	4,500	395,000	Ground, Spring**
4.	Kingston	8.8	5,000	315,000	Ground, Spring+
5.	Lenoir City	9.7	6,500	995,000	Surface (Tennessee River Mile 601.3)
6.	Midtown	10.8	2,090	130,000	Ground, Well
7.	Harriman	10.8	10,000	2,359,000	Surface (Emory River Mile 12.9)++
8.	Loudon	11.4	5,000	489,000	Ground, Spring
9.	Piney Utility District	12.2	2,000	75,000	Ground, Spring
10.	Paint Rock Elementary School	12.4	250	6,200	Ground, Well
11.	Midway High School	12.6	515	12,900	Ground, Spring
12.	Oliver Springs	14.5	3,570	188,000	Ground, Spring
13.	First Utility District of Knox County	14.5	10,500	1,051,000	Surface (Sinking Creek embayment)
14.	West Knox Utility District	15.3 and 17.8	18,000	1,000,000	Surface (Clinch River Mile 46.9) and Ground, Spring

(Continued)

TABLE 2.2-20 (Continued)

	Supply	Approx. Radial Distance from Site (miles)	Population Served	Average Daily Use (gallons)	Source
15.	Dutch Valley Elementary School	16.8	140	3,500	Ground, Well
16.	First Utility District of Anderson Co.	17.1	3,600	270,000	Ground, Spring
17.	Hallsdale-Powell Utility District	17.5	22,000	1,500,000	Surface (Bull Run Creek embayment)∇
18.	Plateau Utility District	17.7	1,900	100,000	Ground, Well
19.	Brushy Mountain State Honor Farm	17.9	195	60,000	Ground, Well
20.	Rockwood	18.0	5,500	1,200,000	Ground, Spring and Surface (King Creek embayment)
21.	Clinton Utility Board	20.0	17,000	820,000	Surface (Clinch River Mile 59)
22.	Sweetwater	20.0	5,100	700,000	Ground, spring and surface (Sweetwater Creek)

*Also has auxiliary water intake at Little Emory River Mile 3.9

**Includes Martel Utility District

+Also has auxiliary water intake at Tennessee River Mile 568.2

++Includes Swan Pond Utility District

∇This figure includes water withdrawn from sources outside of the 20-mile radius.

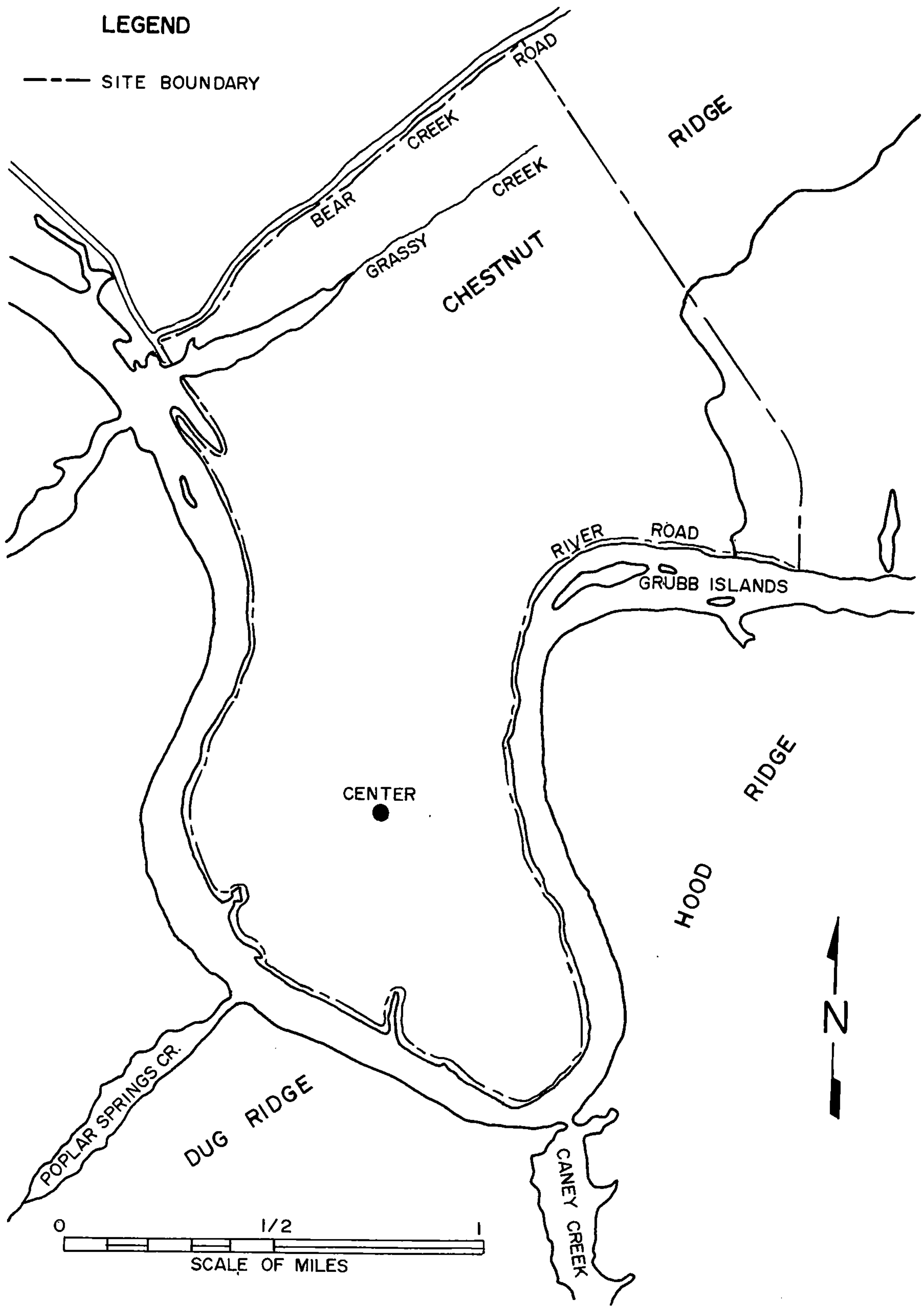


Figure 2.2-1 APPROXIMATE CENTER OF PENINSULA USED FOR DEMOGRAPHIC ANALYSIS

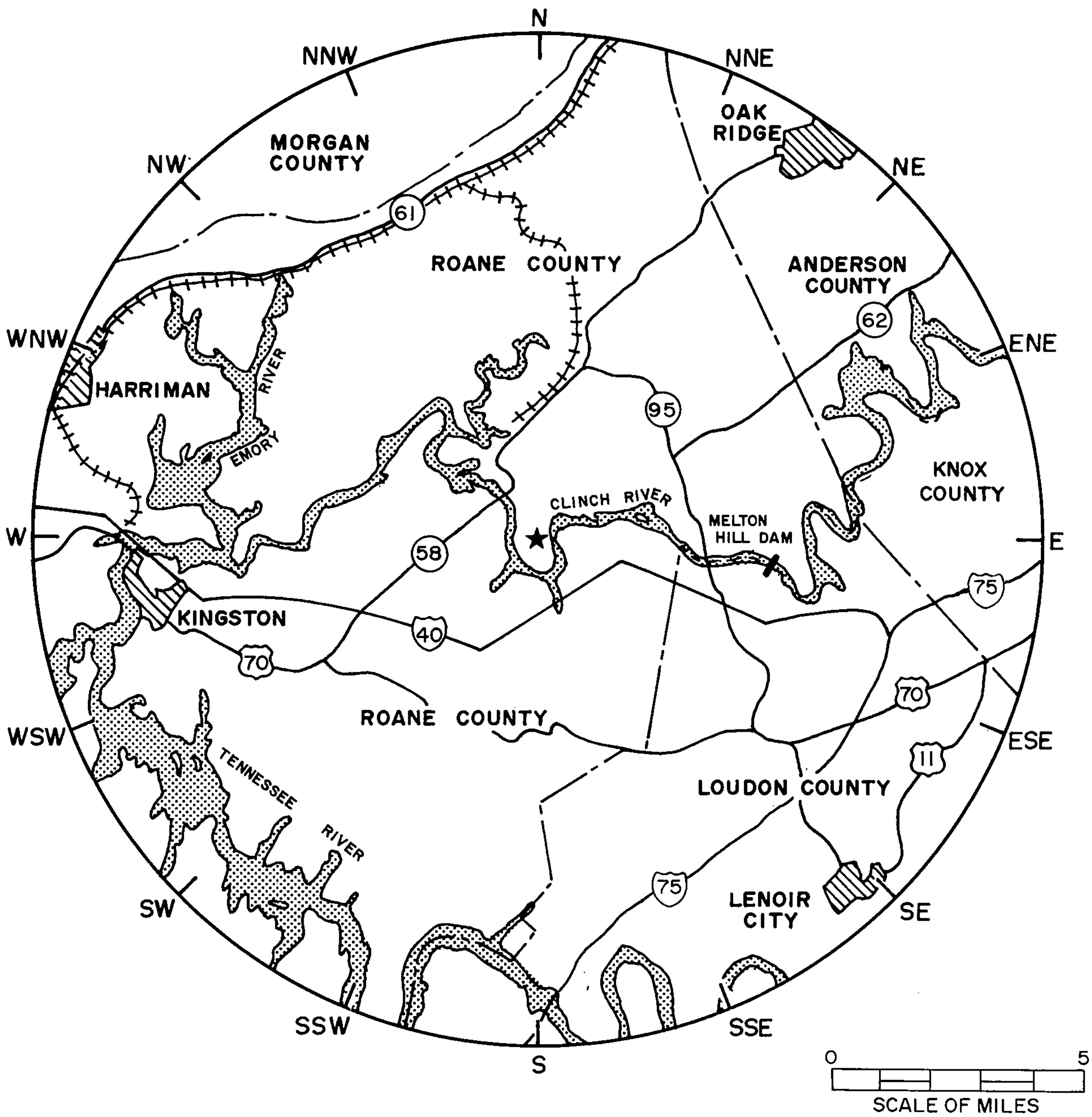


Figure 2.2-2 URBAN AREAS WITHIN 10 MILES OF THE CLINCH RIVER SITE

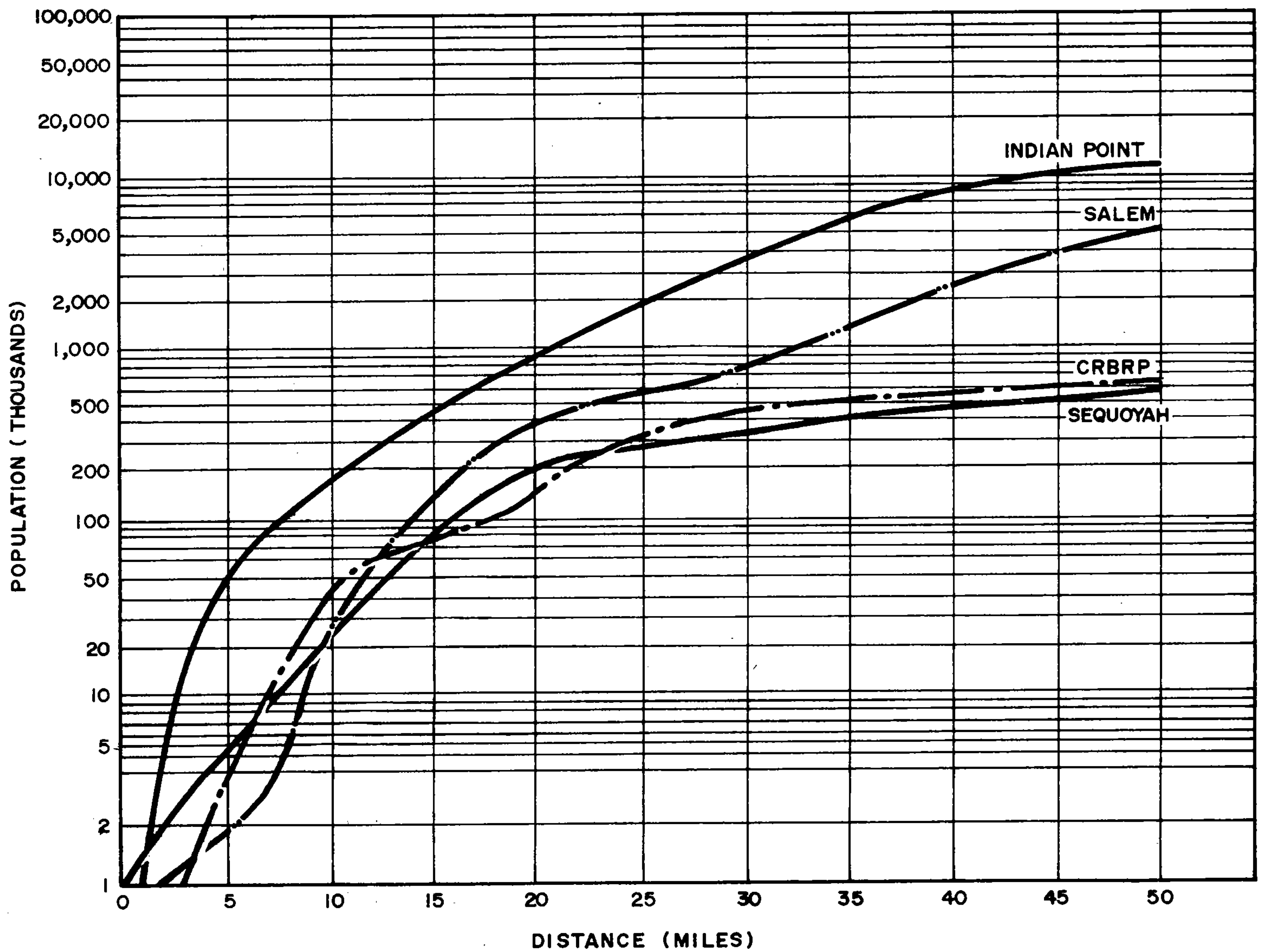


Figure 2.2-3 COMPARATIVE POPULATION DISTRIBUTION SURROUNDING NUCLEAR PLANT SITES

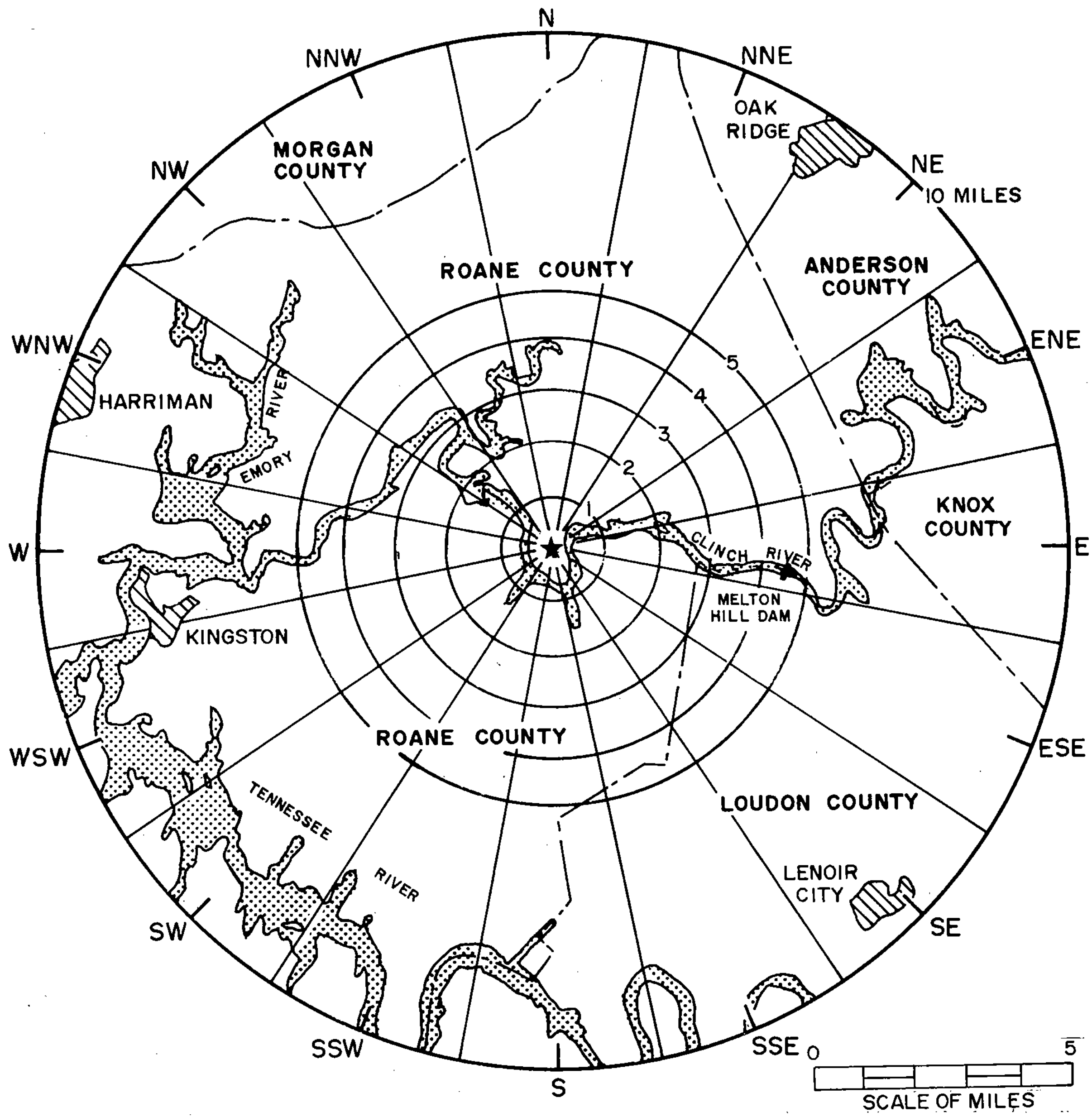


Figure 2.2-4 SECTOR DESIGNATIONS FOR 1, 2, 3, 4, 5 AND 10 MILES

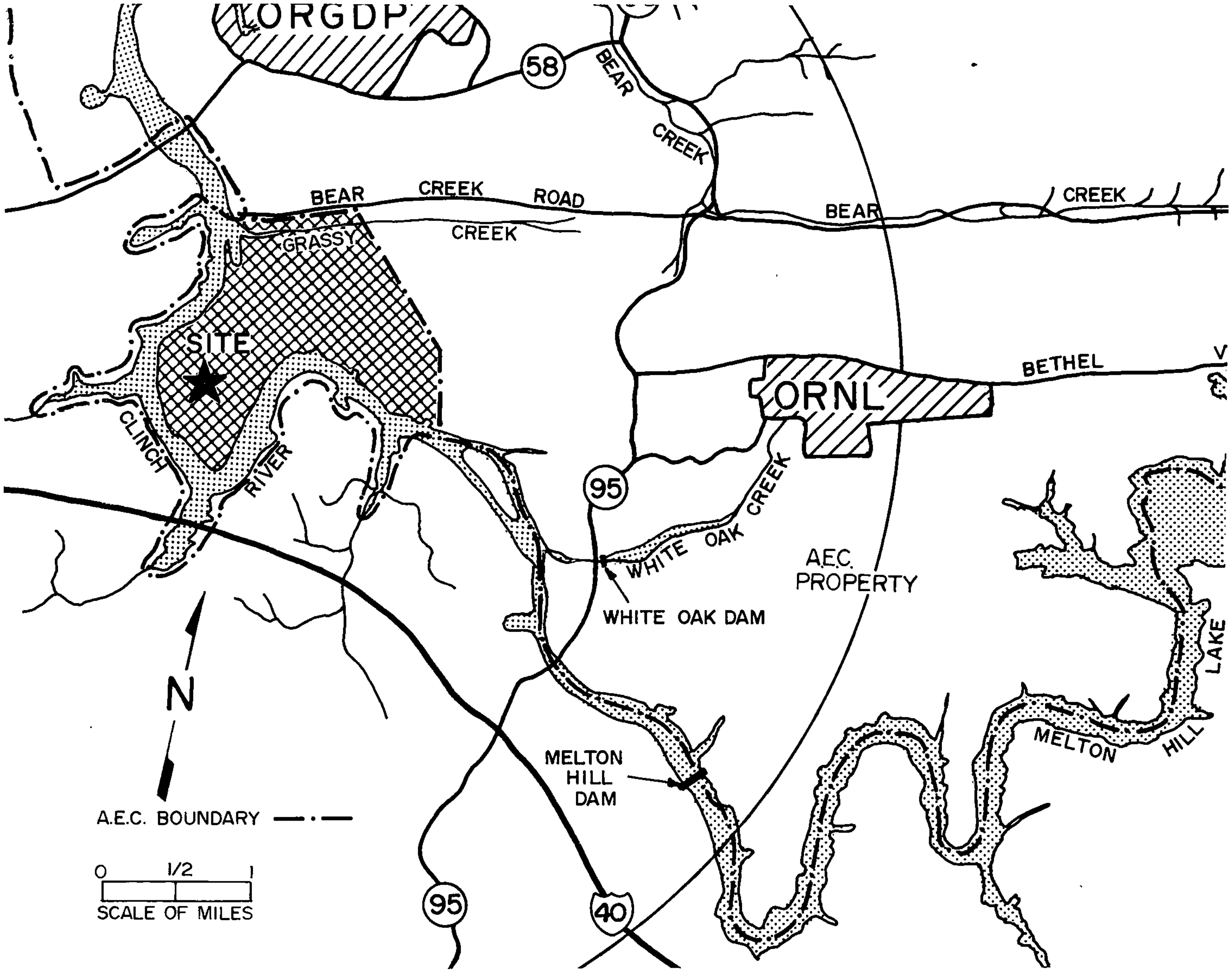


Figure 2.2-5 AEC BOUNDARY RELATIVE TO CLINCH RIVER SITE

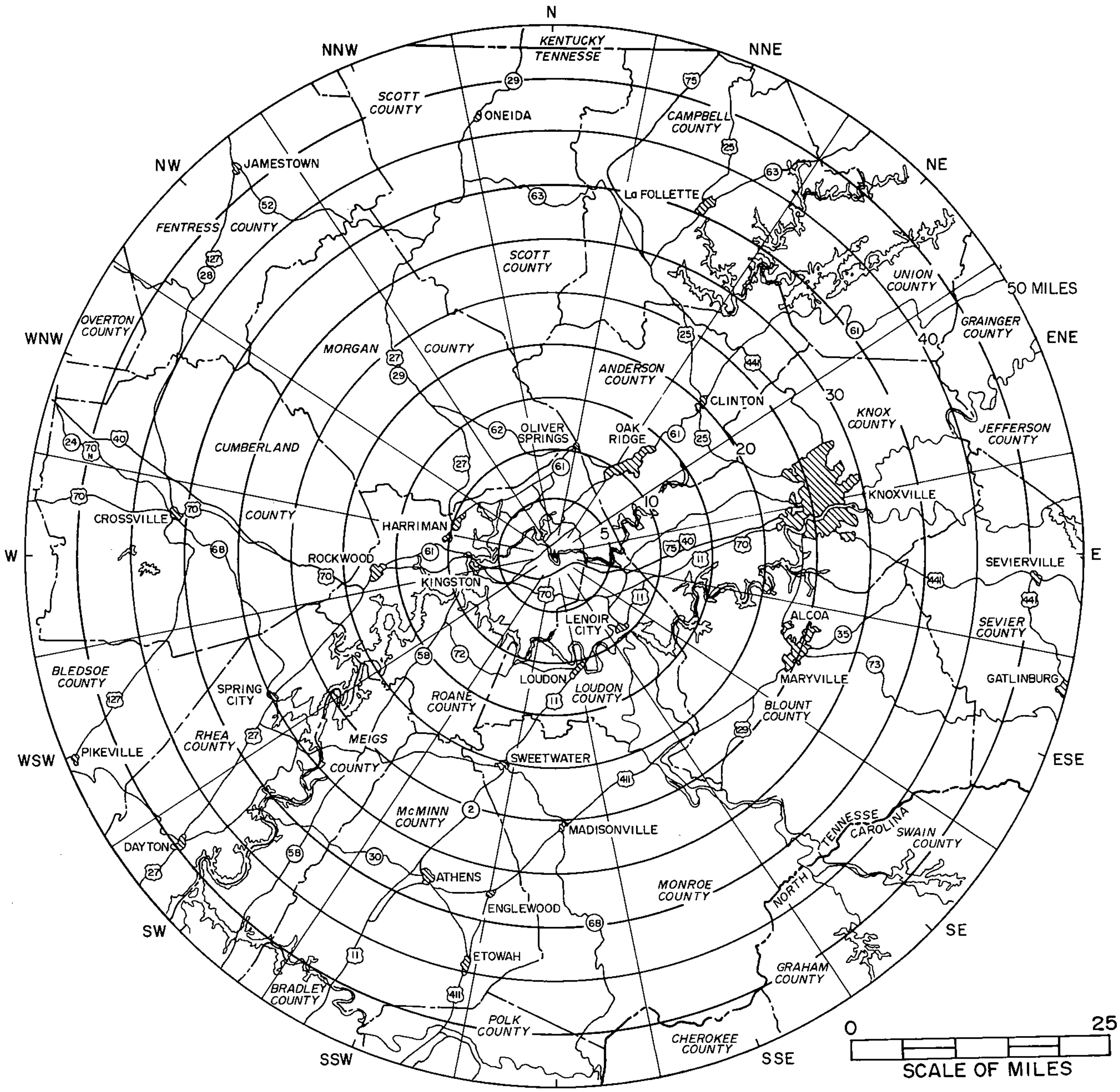
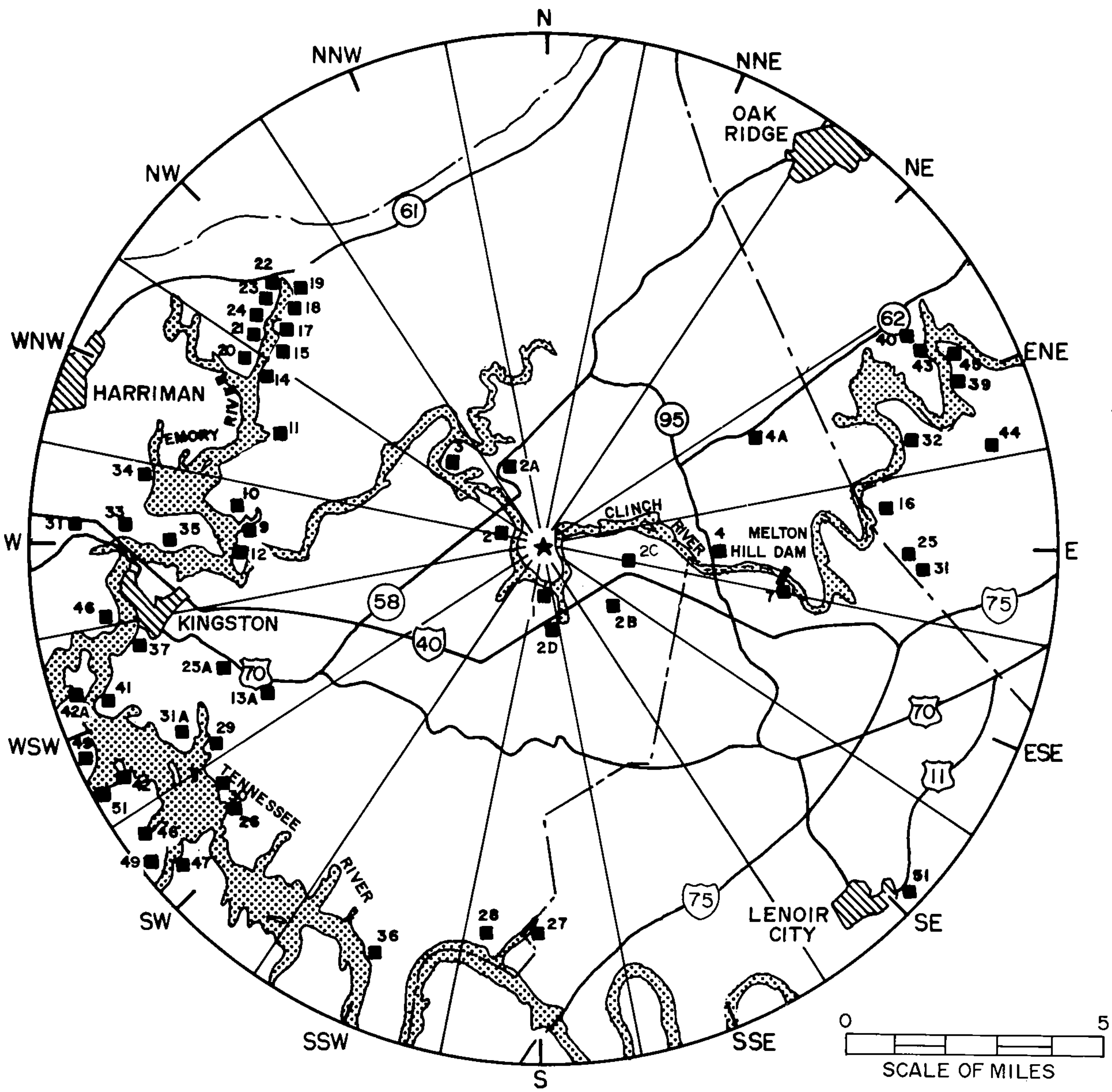


Figure 2.2-6 URBAN CENTERS WITHIN 50 MILES OF CLINCH RIVER SITE



■ RECREATIONAL SITE NUMBERS ARE KEYED TO TABLE 2.2-14

Figure 2.2-7 RECREATIONAL AREAS WITHIN 10-MILE RADIUS OF CLINCH RIVER SITE

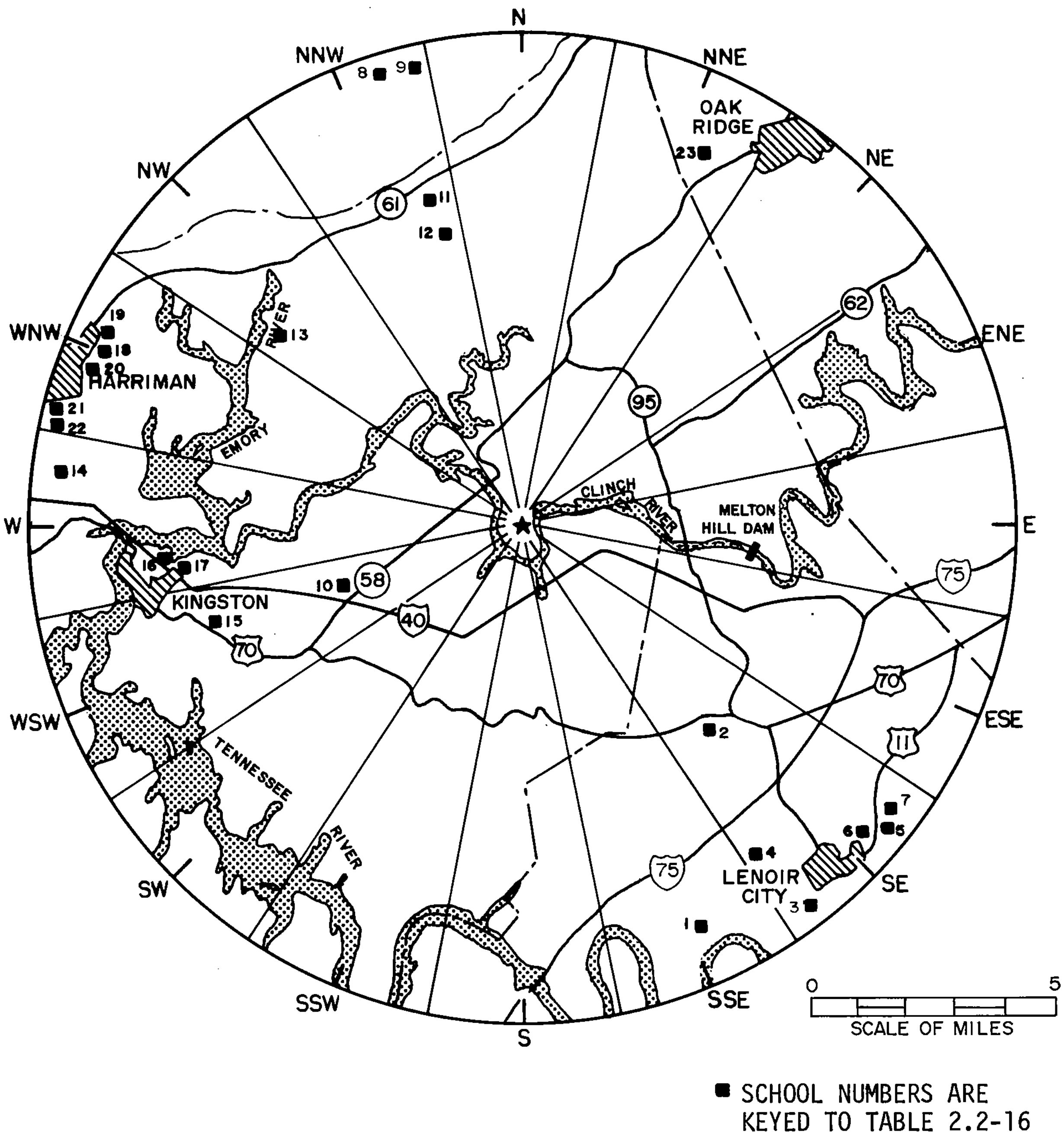


Figure 2.2-8 SCHOOLS WITHIN 10-MILE RADIUS OF CLINCH RIVER SITE

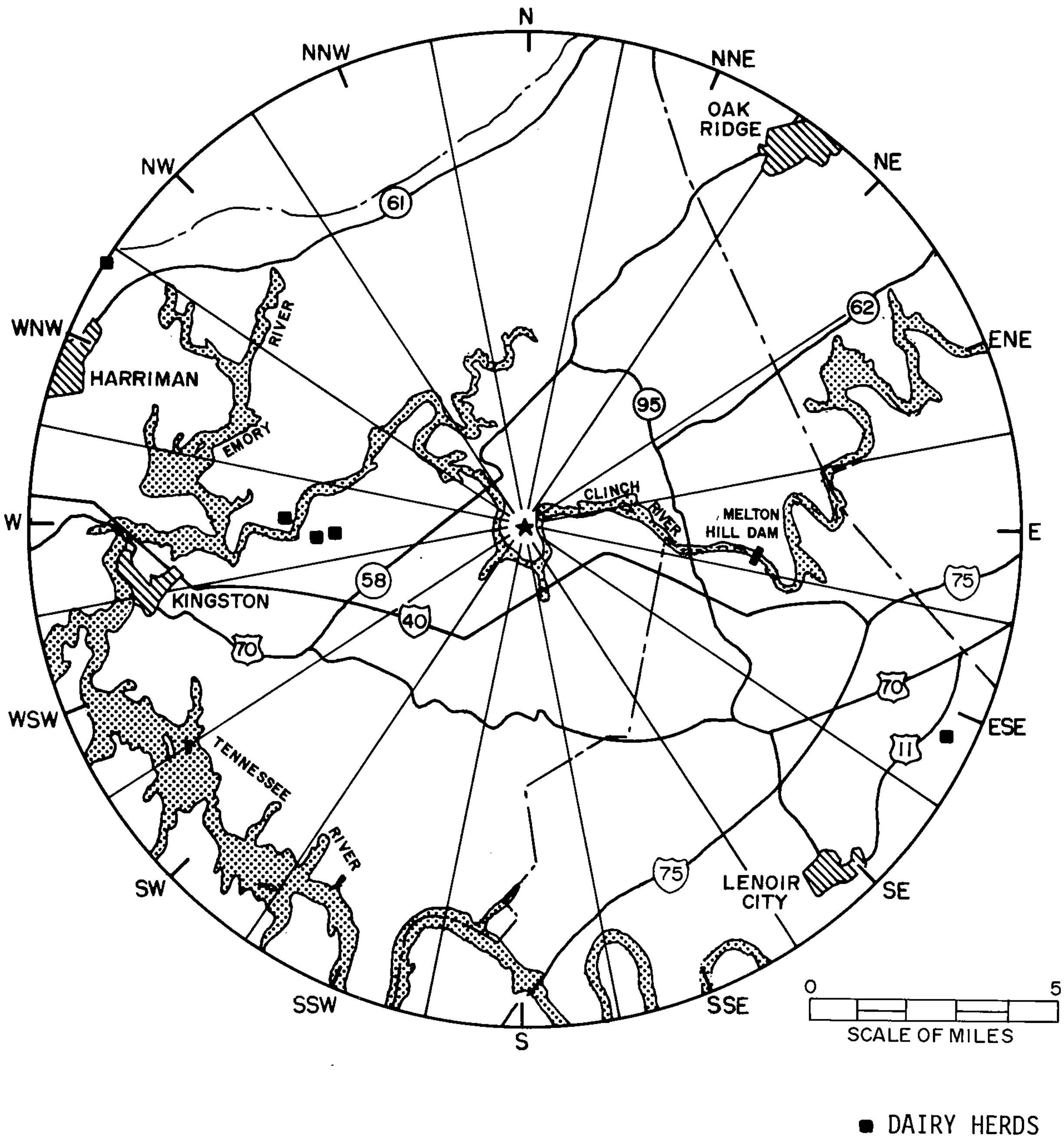


Figure 2.2-9 DAIRY HERDS WITHIN 10-MILE RADIUS OF CLINCH RIVER SITE

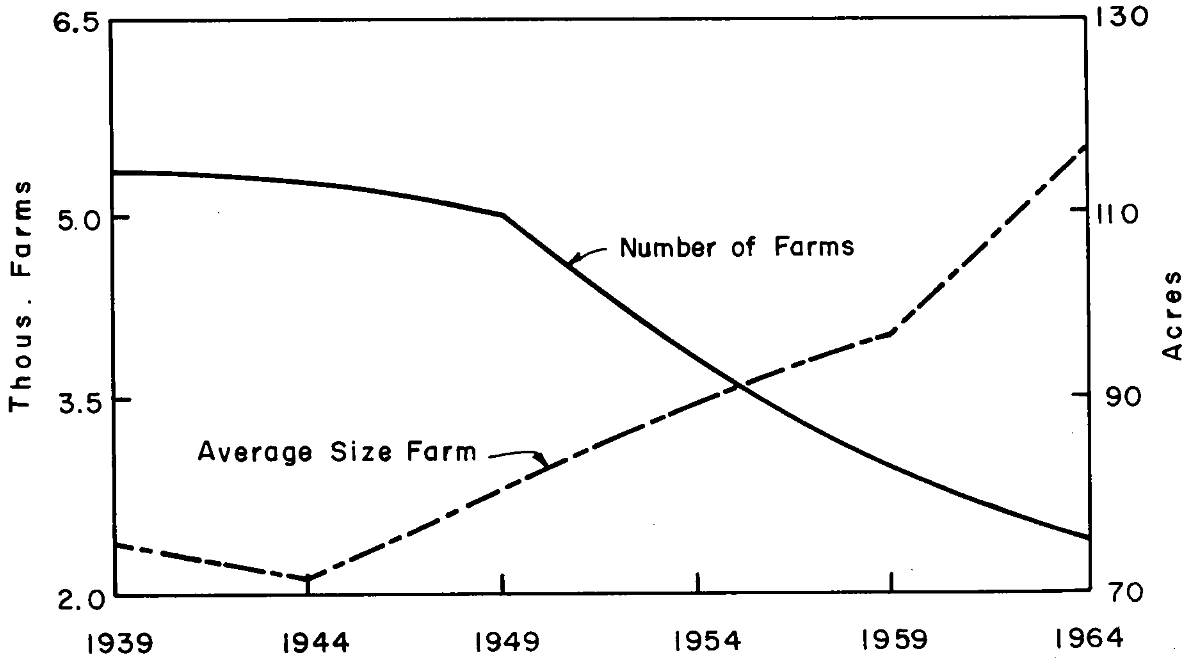


Figure 2.2-10 EMORY RIVER VALLEY, NO. AND AVG. SIZE FARMS 1939-1964(7)

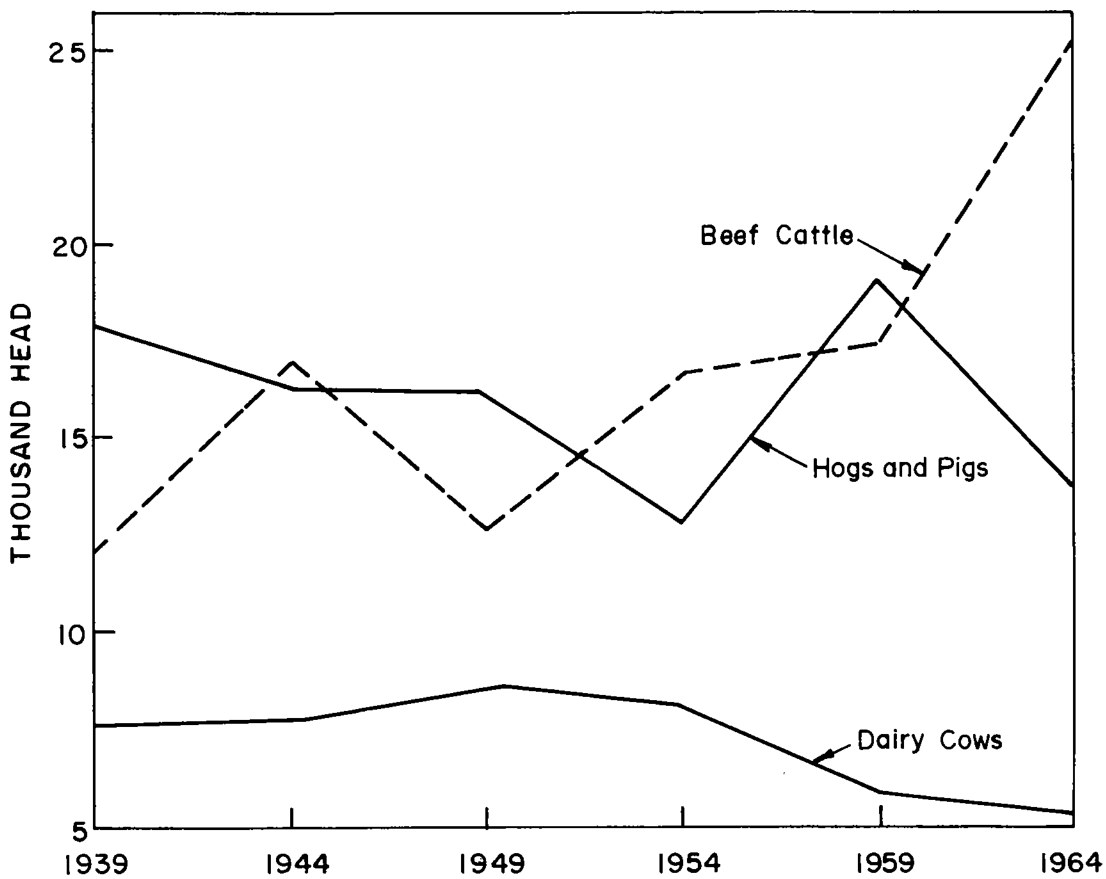
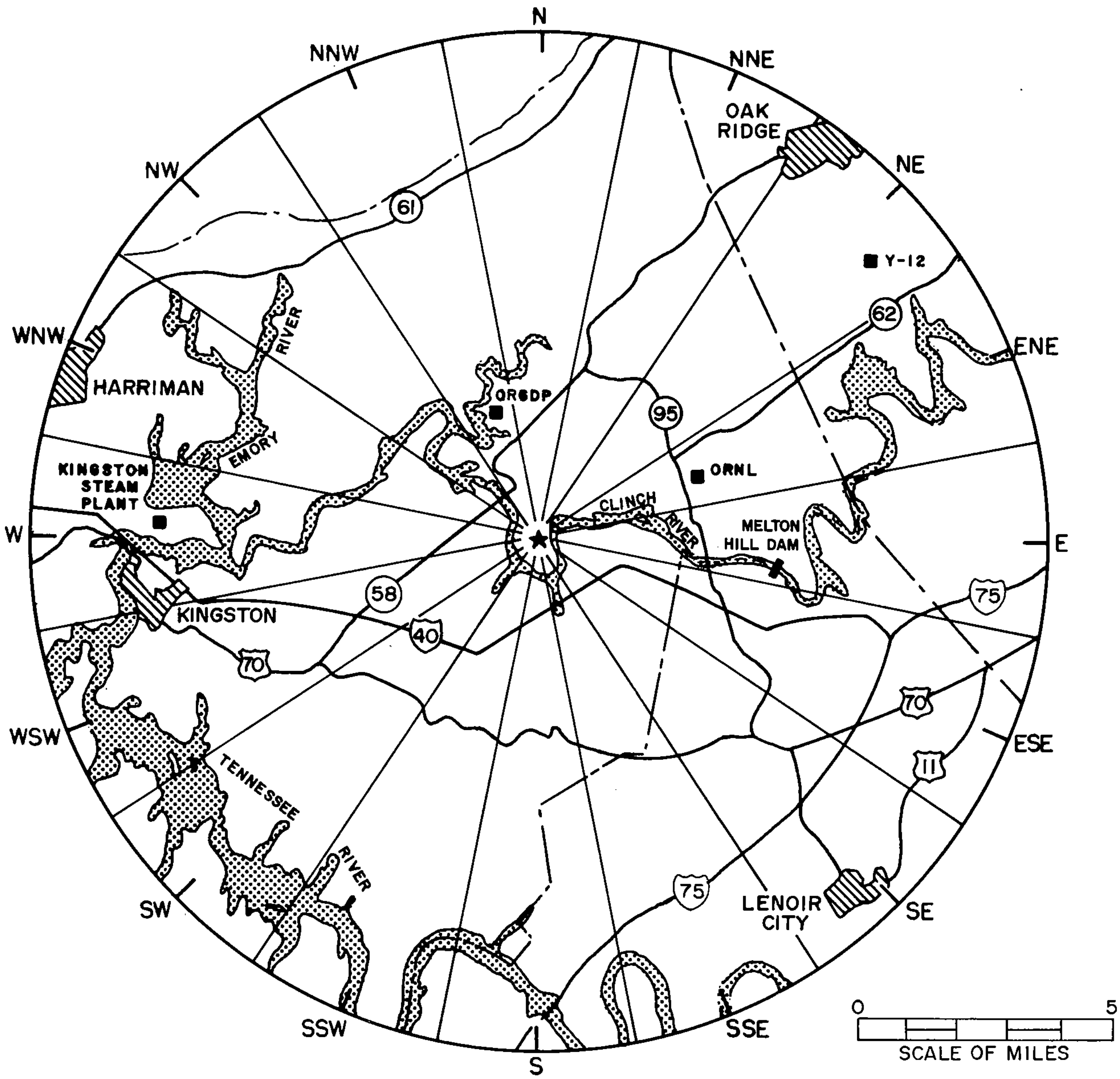


Figure 2.2-11 EMORY RIVER VALLEY, LIVESTOCK ON FARMS 1939-1964(7)



■ INDUSTRIAL PLANTS

See Figure 2.2-13 for the Clinch River Consolidated Industrial Park

Figure 2.2-12 INDUSTRIAL PLANTS WITHIN 10-MILE RADIUS OF CLINCH RIVER SITE

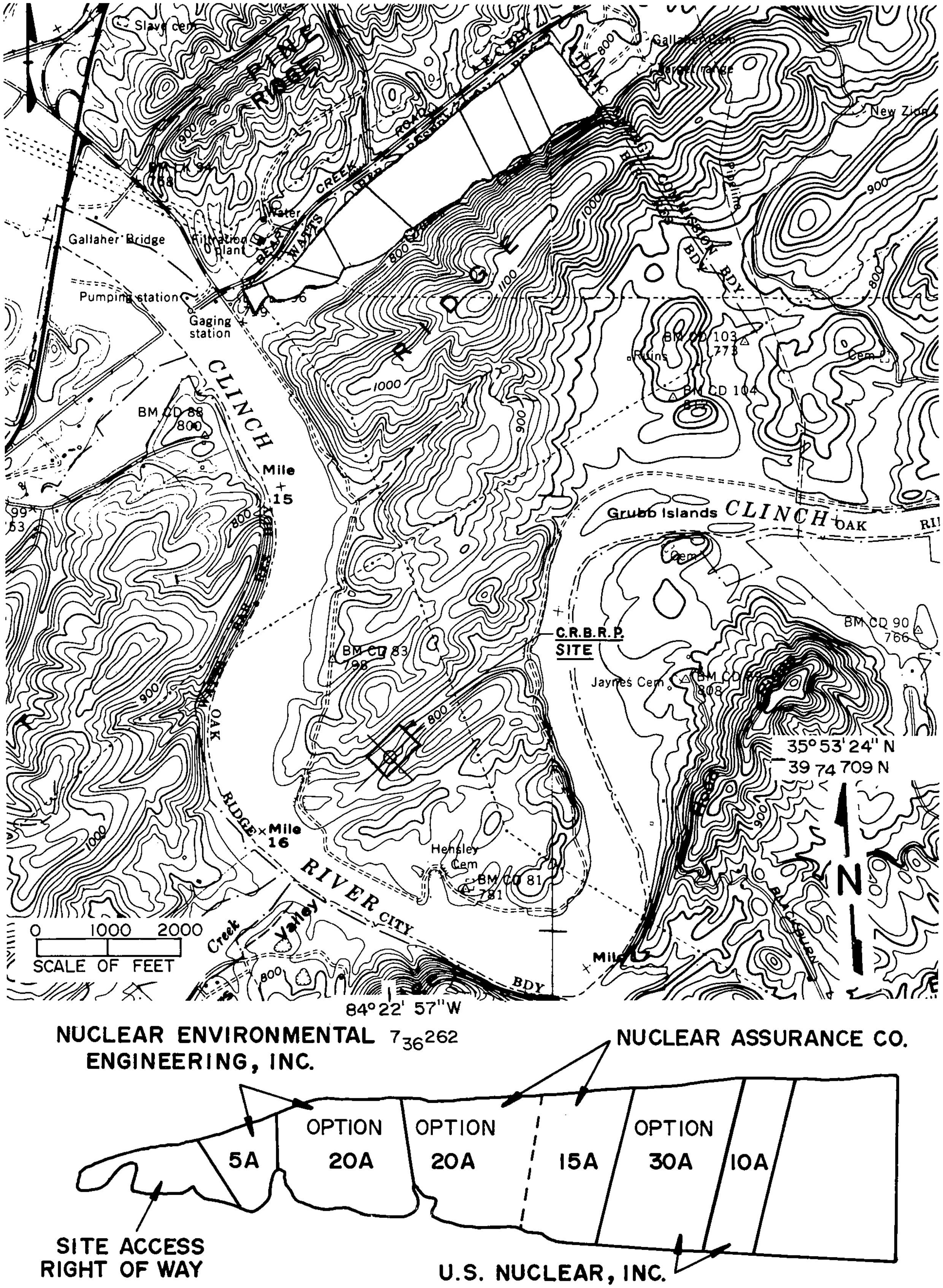


Figure 2.2-13 CLINCH RIVER CONSOLIDATED INDUSTRIAL PARK

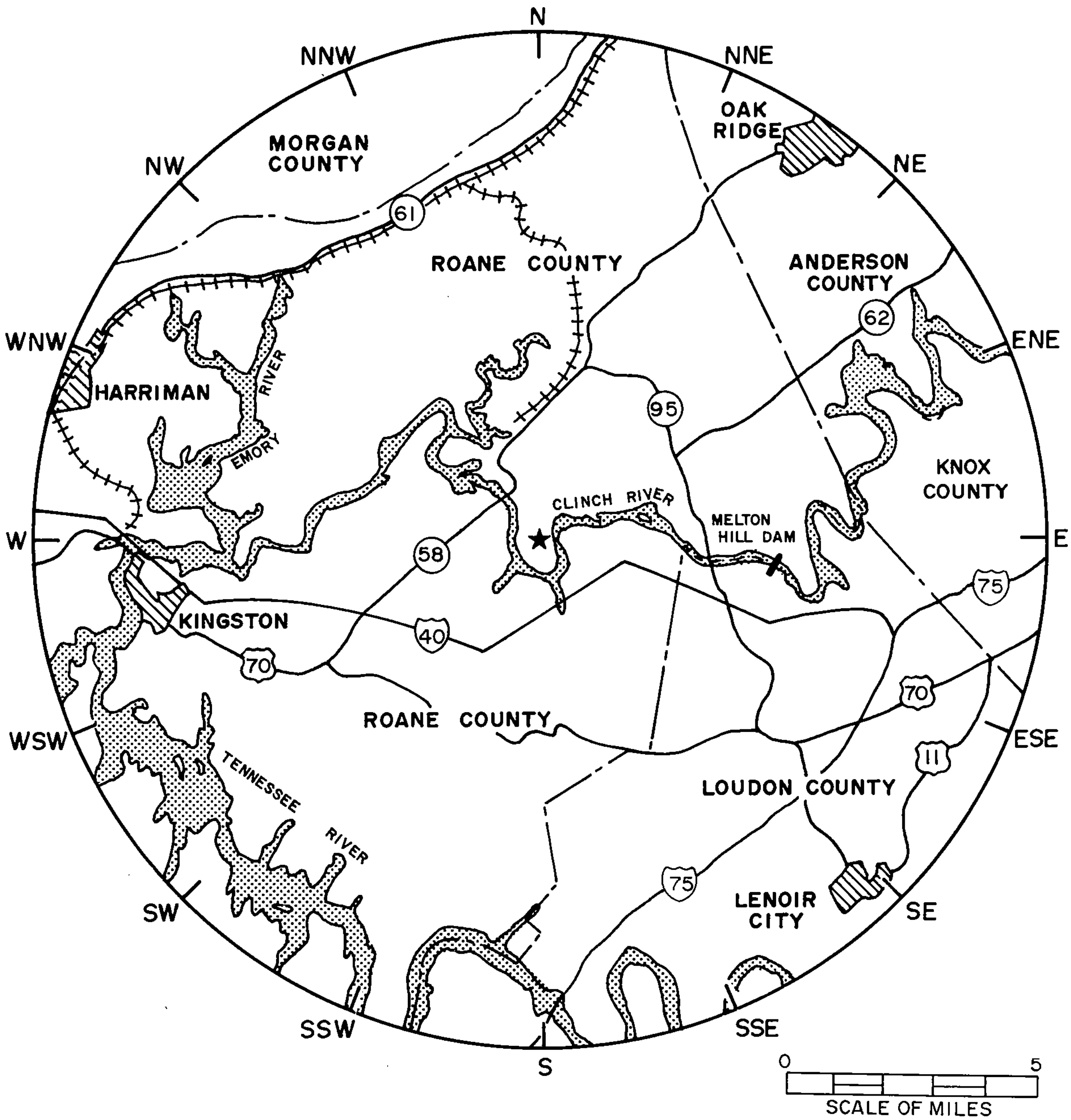


Figure 2.2-14 CLINCH RIVER SITE MAJOR HIGHWAYS

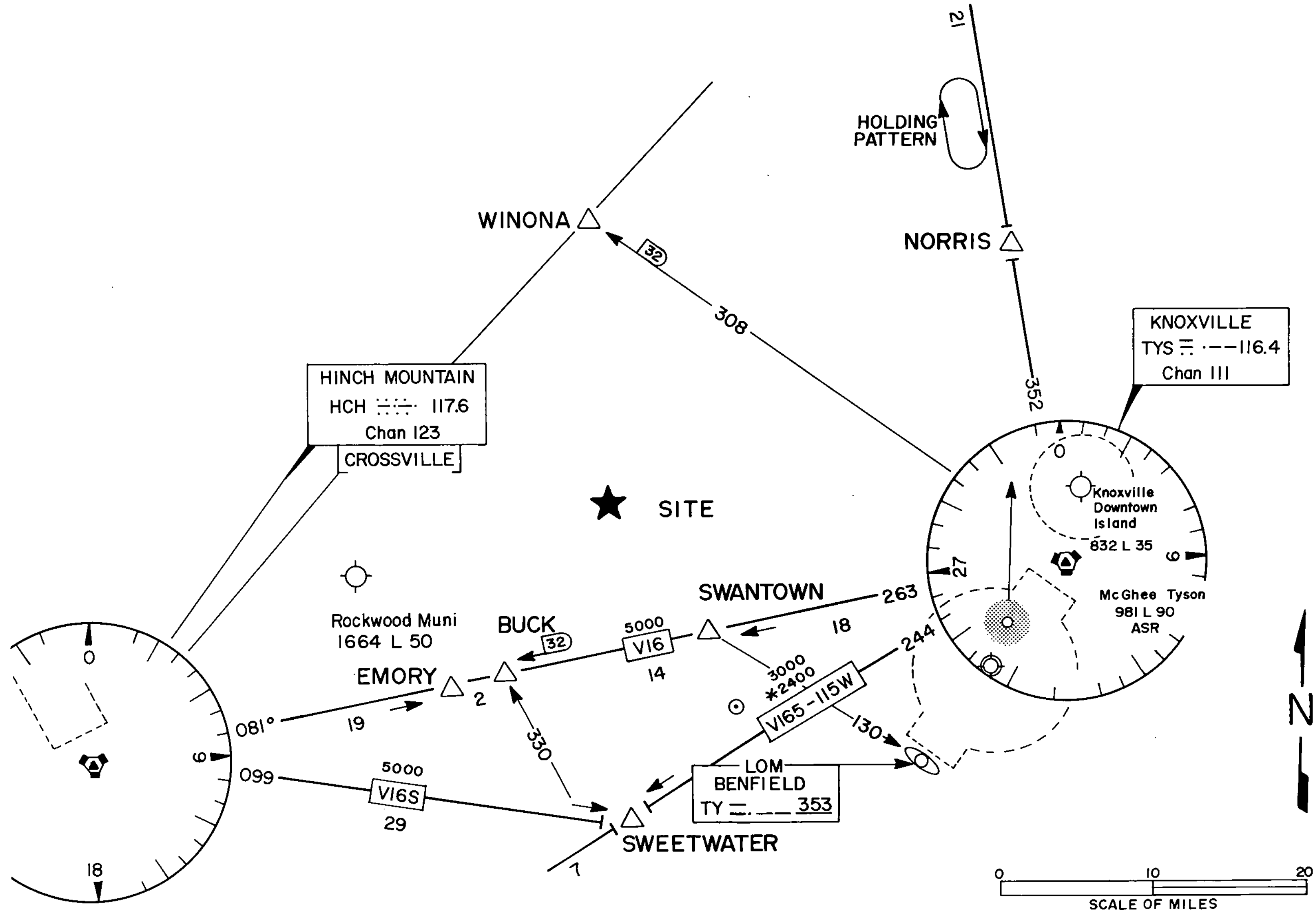
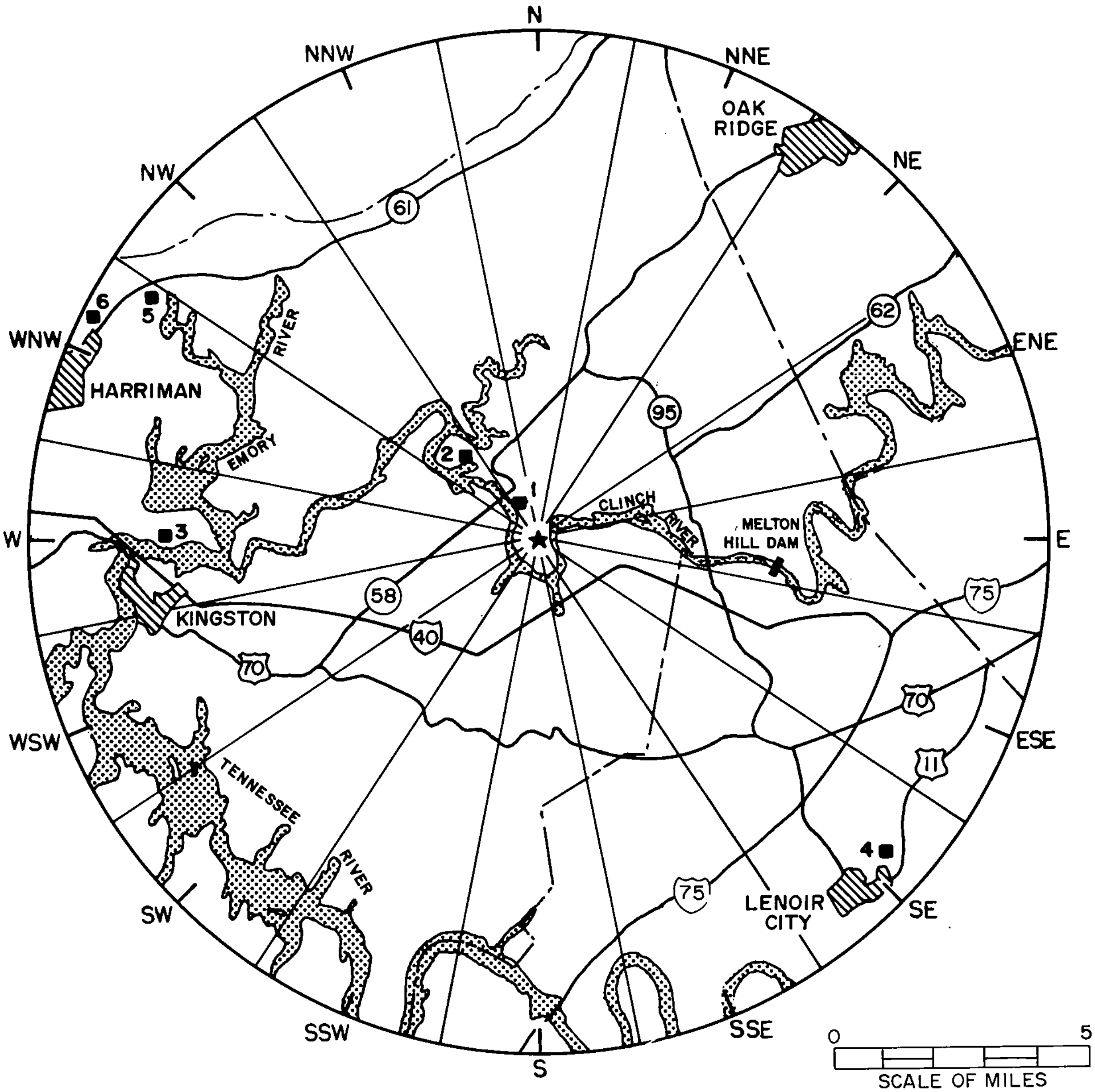
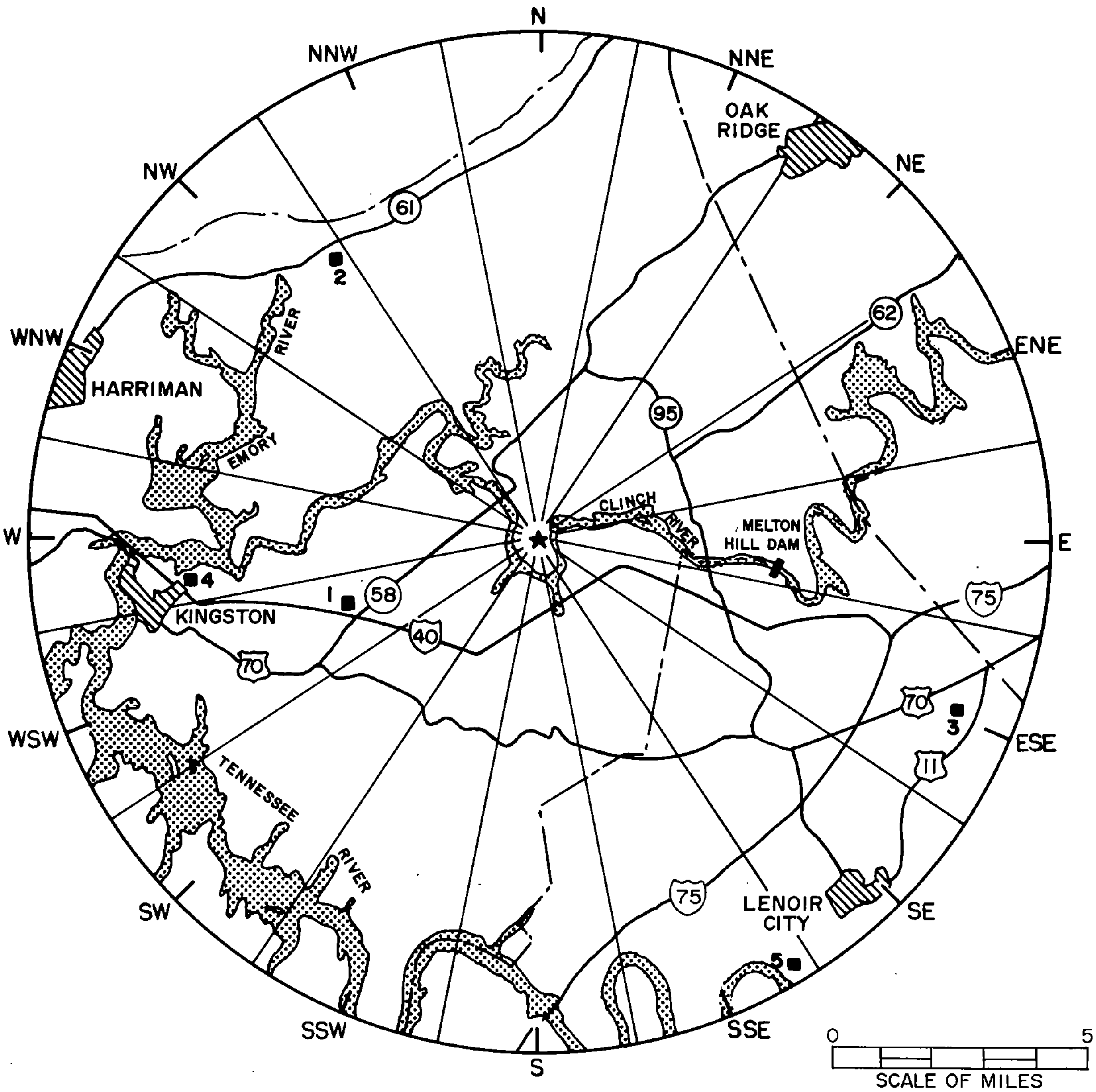


Figure 2.2-15 COMMERCIAL AIR TRAFFIC PATHS NEAR CLINCH RIVER SITE



■ INDUSTRIAL WATER SUPPLY
NUMBERS ARE KEYED TO
TABLE 2.2-19

Figure 2.2-16 INDUSTRIAL WATER SUPPLIES WITHIN 10-MILE RADIUS OF CLINCH RIVER SITE



■ PUBLIC WATER SUPPLY
NUMBERS ARE KEYED TO
TABLE 2.2-20

Figure 2.2-17 PUBLIC WATER SUPPLIES WITHIN 10-MILE RADIUS OF CLINCH RIVER SITE

2.3 REGIONAL HISTORICAL, SCENIC, CULTURAL AND NATURAL LANDMARKS

The following discussion of features or landmarks, particularly of those located on the Site, has been separated into three sub-sections; (1) scenic and natural; (2) historical; and (3) archaeological. Historical features include those structures or sites that are of Euro-American origin. Indian burial mounds and middens are examples of prehistoric or archaeological sites.

In Figure 2.3-1, archaeological sites have been designated by triangles and historical sites by circles; one exception is the Hensley Cemetery which has been designated by a square. Each site has a "key" number which has been assigned in accordance with the Smithsonian Trinomial Site Designation System used throughout the United States. In this system, the first number or numbers indicate the state (numbered alphabetically), the letters indicate the county in that state and the final number or numbers indicate the sequential recording of the sites discovered in that county. For example, 40RE123 means this site is located in the state of Tennessee (40), Roane County (RE) and is the 123rd site to be discovered and recorded in Roane County. Thus, when a new site is discovered, it is assigned a "key" number and recorded in county, state and national registers.

2.3.1 SCENIC AND NATURAL LANDMARKS

Steep limestone ridges, hills and knobs are characteristic features of the region. Numerous small wet-weather streams drain the area and in many places along the river, thick alluvial sediments form flood plains which vary in width from a few feet to several hundred feet. The plant site and the surrounding area are heavily wooded with both coniferous and deciduous trees. A combination of various vines, grasses, shrubs and trees forms a dense ground cover.

The peninsula on which the plant will be located is formed by a meander of the Clinch River approximately between river miles 15 and 18. A detailed description of the area is in Section 2.1 and Figure 2.1-3 shows the CRBRP in relation to the Site.

Investigation of the Site has revealed no unique points of scenic or natural significance.[1] Natural landscape of the area will restrict public view of the Site. A portion of the dome of the Reactor Containment Building may be visible from the Gallaher Bridge on the Oak Ridge Turnpike. Approximately ten homes on the southern side of the Clinch River will have a limited view of the plant. Because the Site is owned by the U. S. Government and is in the custody of TVA, the area has been restricted to the public since the 1940's and visitation has been limited. Until the Site was proposed as the area for the Clinch River Breeder Reactor Plant (CRBRP), it had been designated by TVA for industrial development.[2]

2.3.2 HISTORIC FEATURES

The "National Register of Historic Places" lists the Museum of Atomic Energy in Oak Ridge and the ORNL Graphite Reactor, both of which are within 10 miles of the Site. Within the boundaries of the Site, the only known cultural significance is that possibly associated with the sites discussed below and shown in Figure 2.3-1.

A search was made for structures and sites of historical significance within the Site boundaries. The investigation was led by Dr. Gerald F. Schroedl, Research Assistant Professor, and Dr. Prentice M. Thomas, Jr., Assistant Professor of Anthropology, from the Department of Anthropology, University of Tennessee, in October 1972 and January 1973. Four Euro-American farmsteads (40RE120, -121, -122 and -123) and an historic cemetery (40RE119), shown in Figure 2.3-1, were located and recorded. The following descriptions of these sites were abstracted from reports written by Dr. Gerald F. Schroedl[3] and Dr. Prentice M. Thomas, Jr.[4]

Site 40RE119, Hensley Cemetery. The cemetery is located on the southern tip of the peninsula outside the construction perimeter. It is a fenced 75-foot-square area containing five marked graves. Identifiable markers include those of S. S. Hensley (1854-1927), Lou Anna Peters (1885-1917), Callie D. Peters (1883-1941) and Stella Harvey (1921-1922). These four graves are located along the northern edge of the cemetery. In addition, there is one small illegible metal marker in the southeast corner of the cemetery. Because the cemetery is of local historical significance, it will be preserved. The Hensley family will retain the right of access to visit the cemetery.

Site 40RE120. Remains on the site consist of a collapsed house, a standing limestone fireplace with two opposing hearths, a limestone-lined root cellar, a rectangular brick-lined cistern, a portion of a fence of split logs and a shed.

Site 40RE121. This site consists of the remains of a house, well, cellar, two small outbuildings and three rectangular pits, all enclosed by a hand-split picket fence. Remains of three chimneys (one standing and two collapsed), four limestone corner supports and two porch supports characterize the house. The remains of a log crib face a rectangular stone-lined cellar on the south side of the house. East of the house are two additional structures, a well-house covering a circular stone-lined well and the remains of a barn.

Site 40RE122. The site consists of a wood frame house and barn. Both are standing, but numerous roof and floor supports have collapsed. Both structures appear to date from the early twentieth century.

Site 40RE123. When the initial investigation of the site was made in 1972, a single isolated rectangular log structure was recorded. The structure was constructed of large hand-hewn logs and was covered by a partially collapsed peak-frame roof. It was a single entry structure which had no fireplace or windows. This suggested that the structure had been utilized as a storage facility rather than a dwelling. Size of the logs and the construction technique suggested that the building may have dated from the second half of the nineteenth century. In October 1973, Dr. Schroedl reported that this structure had been destroyed sometime between October 1972 and October 1973 when the detailed photographs and drawings were to be made. Officials of TVA and, in turn, officials of PMC were informed of the incident.

None of the above sites or structures has historical significance that would qualify for inclusion in the National Register.(5) Detailed photographs and drawings have been completed for each site and preservation of these sites, other than the cemetery, is not required.

A search was made for other structures or sites that may have been missed due to the dense vegetation on the Site. In addition, land maps and county records, such as documents on file at the McClung Museum at the University of Tennessee, were reviewed.(6) Several new sites were located, photographed and recorded. None of these sites requires preservation.

2.3.3 ARCHAEOLOGICAL FEATURES

Results of the archaeological surveys conducted during the periods of October 13-15 and 27-29, 1972, indicated the presence of significant archaeological resources. Additional testing of one of the sites, a burial mound (site 40RE124), was conducted by Dr. Schroedl on March 17 and 23, 1973.(7) Three burials discovered during preliminary tests on the mound indicated that a more detailed investigative program was needed.

Previous archaeological reconnaissance and excavation had been done in the region. In April 1886, Cyrus Thomas and his associates visited the lower Clinch River and reported a complex of mounds and associated camps, villages and burials on the north side of the Clinch River between CRM 20 and 21.[8] Further archaeological surveys were not conducted until 1941 when reconnaissance of the Watts Bar Reservoir area was made.[6] At that time five sites were located in the area between CRM 15 and 18, but none of these sites were tested or excavated. Additional surveys and excavations along the Clinch River were initiated in 1960 and 1961 in the Melton Hill Dam Reservoir area.[9,10]

The main thrust of the investigations in 1972 was to reevaluate the archaeological sites located during the previous surveys and to determine if other archaeological resources existed. This investigation was concentrated in the immediate area of the proposed plant and along the anticipated routes of the access highway and railroad. No new sites of archaeological interest were located.

Therefore, the 1972 survey concentrated on locating, testing and evaluating the six archaeological sites (40RE102, -105, -106, -107, -108 and -124) originally recorded during the 1941 survey. Several test pits were excavated at each of these sites, but diagnostic cultural materials were recovered only from the burial mound and the two midden (refuse) locations (40RE124, -107 and -108, respectively). These materials indicated the presence of significant archaeological resources and the need for further study and excavation of these three sites.

Locations of the six archaeological sites are shown in Figure 2.3-1. The site descriptions below were abstracted from Dr. Schroedl's reports on the test excavations.[3,7]

Sites 40RE104, -105 and -106. These sites yielded few cultural materials. It was impossible to confirm the cultural affiliation of each site from the artifacts recovered. Test excavations indicated no further investigation of these sites would be required.

Site 40RE107. Cultural material recovered from this site included six cryptocrystalline chipping debris and one cryptocrystalline preform.

Site 40RE108. Cultural material from this site consisted of one knife or projectile point tip, two grit tempered plain body sherds, one limestone tempered plain body sherd, one limestone tempered fabric-marked body sherd and numerous whole and fragmented river mussel shells.

Site 40RE124, Burial Mound. A test excavation consisting of a 20- by 3-foot trench was made into an undisturbed conical burial mound. The discovery of three burials and a variety of cultural materials indicated that a more detailed program of investigation was needed. A security fence was erected around the mound to protect it from vandalism.

From preliminary analyses, it appeared that sites 40RE107 and -108 were occupied during the Early Woodland Period. Little is known about the Woodland Period Cultures on the lower Clinch River at the present time. Further testing of 40RE107 and extensive excavations of the shell midden at 40RE108 would help establish possible cultural relationships between Woodland Period sites in the Melton Hill and Norris Reservoir areas with those elsewhere in the Tennessee River Valley. Artifacts and burials found at site 40RE124 suggested a Late Woodland occupation and a possible association with the Hamilton Culture occupations on the lower Clinch River and the Tennessee River in the Watts Bar Reservoir area.

An agreement (TV-39483A) was signed between the Tennessee Valley Authority and the Department of Anthropology, University of Tennessee, based on the research proposal, "Salvage Archaeology in the Clinch River Liquid Metal Fast Breeder Reactor Plant Area."(11) The proposed work included excavation and detailed study of sites 40RE107, -108 and -124, completion of necessary laboratory analyses following the field excavations and publication of a descriptive and interpretive report.

Field excavations began in October 1973 on the burial mound and one midden (sites 40RE124 and -108 respectively) and were completed by February 1, 1974. Laboratory analyses such as washing, cataloging, processing and analyzing the volume of cultural remains, human skeletal remains, faunal remains and botanical specimens will require six to nine months to complete. A final report on the CRBRP archaeological excavations, including site maps, drawings and photographs, is expected to be completed in January 1975.

Results of the field investigations have been briefly summarized below. These summaries were abstracted from Dr. Schroedl's monthly progress reports.[12,13,14,15]

Site 40RE107. Because of the time limitation placed on field work and the necessity for more detailed excavation of sites 40RE124 and -108 than was originally planned, no excavations beyond the initial test pits were attempted on site 40RE107.

Site 40RE108. Initial test excavations revealed a shell midden which had been exposed by slow erosion of the present river bank. Further excavation on the east side of this shell deposit revealed a small, dark organic midden.

A second shell midden was located in November approximately 820 feet upstream. In December, further examination of the beach and river bank downstream from the initial excavation revealed a third but smaller shell deposit (approximately 260 feet to the north). About 160 feet beyond this shell deposit, an extensive organic midden was exposed in the river bank. Lithic debris and artifacts, pottery sherds and fire-cracked rocks were associated with this deposit, but no shells were observed. These last two middens were not recorded during the 1941 survey of Watts Bar Reservoir. Because these middens were in the same vicinity and contained similar ceramics, they probably represented similar and contemporary occupations; the four areas may have served related, but possibly distinct, activities.

Site 40RE124. The most important archaeological site located within the Site boundaries was a Late Woodland Period burial mound. Importance of this mound can be attributed to three unique facts; the burial mound had not been plowed, substantially eroded, or plundered by relic collectors.

Field work at site 40RE124 was completed by February 1, 1974. Virtually all mound sediments had been removed down to the original premound surface. All burials and features were recorded and removed. The distribution of burials by mound construction stage at 40RE124 is shown in Table 2.3-1. These assignments are based solely on field interpretations and detailed laboratory analyses will be conducted for precise determination of the minimum number of individuals. Preliminary interpretations of the recovered samples show that a probable minimum number of 36 individuals were interred in the mound.

Completed excavations confirmed the hypothesis that three distinct mound construction stages existed as shown in Figure 2.3-2. Construction Stage 1 was initiated with the interment of a single individual in a shallow oval pit dug into the premound surface. Fill was placed over the burial pit to form a low conical mound. A second burial, containing two individuals, was placed along the southeast edge of the mound and more fill added. Limestone slabs were then placed in a regular densely-packed circular configuration on the slopes of the mound, but no slabs were placed on the summit.

Construction Stage 2 contained 17 burials, the greatest number recovered from a single stage. This stage was not uniformly added to the original mound. Three individuals were interred on the west side of the mound where portions of the limestone slabs had been disturbed or removed.

The majority of the burials and the mound fill were added to the south half of the original mound. Thus, in Construction Stage 2 the mound center gradually shifted to the southeast as shown in Figure 2.3-2. Most of the individuals were placed on their side with knees in either a flexed or semi-flexed position and were orientated clockwise around the mound facing the center. Large limestone slabs and charred logs were placed on the surface to terminate Stage 2.

The configuration of the mound again shifted to the southeast during Construction Stage 3 as shown in Figure 2.3-2. Stratigraphic profiles indicated that this stage did not completely cover the northeast side and that considerably less moundfill was utilized for these burials. Fifteen burials were interred in the final mound construction stage. Preservation of the skeletal remains associated with this stage was extremely poor and determination of the minimum number of individuals will depend upon laboratory analysis. Large limestone slabs also marked the termination of Construction Stage 3. The construction stage could not be determined for one burial.

An unexpected but important discovery was that of an occupation midden adjacent to the northeast quarter of the mound. Test excavations and associated stratigraphic interpretation of the mound indicate occupation of this site was initiated shortly after completion of the burial mound. Although the mound is associated with the Late Woodland Period, artifacts recovered from the midden are typical of the Early Mississippian Period.

One of the most intriguing archaeological problems in Eastern Tennessee is the relationship between the Late Woodland Period Hamilton Cultures and the Early Mississippian Hiwasse Island Cultures. This discovery of an Early Mississippian midden adjacent to a Late Woodland burial mound possibly will provide new information about the relationship between these two cultures.

2.3.4 EFFECTS OF PLANT CONSTRUCTION AND OPERATION

Investigation of the Site has revealed no significant scenic or natural landmarks. No structures or sites exist that would qualify for inclusion in the National Register. The only site of local historical interest is the Hensley Cemetery. Relocation of the graves will not be required because the cemetery is located on the southern tip of the peninsula beyond the construction perimeter of the CRBRP. The Hensley family will retain the right of access to the cemetery. Two archaeological sites were excavated in depth and materials or artifacts were removed for further detailed study. All field excavations on archaeological sites will be completed by the time construction begins. Power lines which currently traverse the Site and proposed transmission lines for the CRBRP do not and will not pass through any area of known significance. Therefore, construction and operation of the CRBRP will have no significant adverse effect on historic, scenic, cultural or natural landmarks.

TABLE 2.3-1

DISTRIBUTION OF BURIALS BY MOUND CONSTRUCTION STAGE AT 40RE124[15]

Burial	Probable Minimum No. of Individuals	Probable Mound Construction Stage 1	2	3
1	1			X
2A,2B,2C	Undetermined			X
2D*,2E*	but probably 3			
3	1			X
4	1			X
5	1	Associated with Construction Stage 3, but could be intrusive		
6,10	1		X	
7A,7B,7C*	2			X
8	1			X
9	1			X
11	1		X	
12	1		X	
13	1		X	
14	1			X
15	1		Undetermined	
16A,16B	2		X	
17	1		X	
18*	1			X
19*	1		X	
20*	1		X	
21*	1		X	
22*	1			X
23*	1			X
24*	1		X	
25*	1		X	
26*	1		X	
27*	1		X	
28*	1	X		
29A*,29B*	2		X	
30*	1		X	
31A*,31B*	2	X		
Total	36	3	17	15

*Burial excavated, recorded and removed during January, 1974.

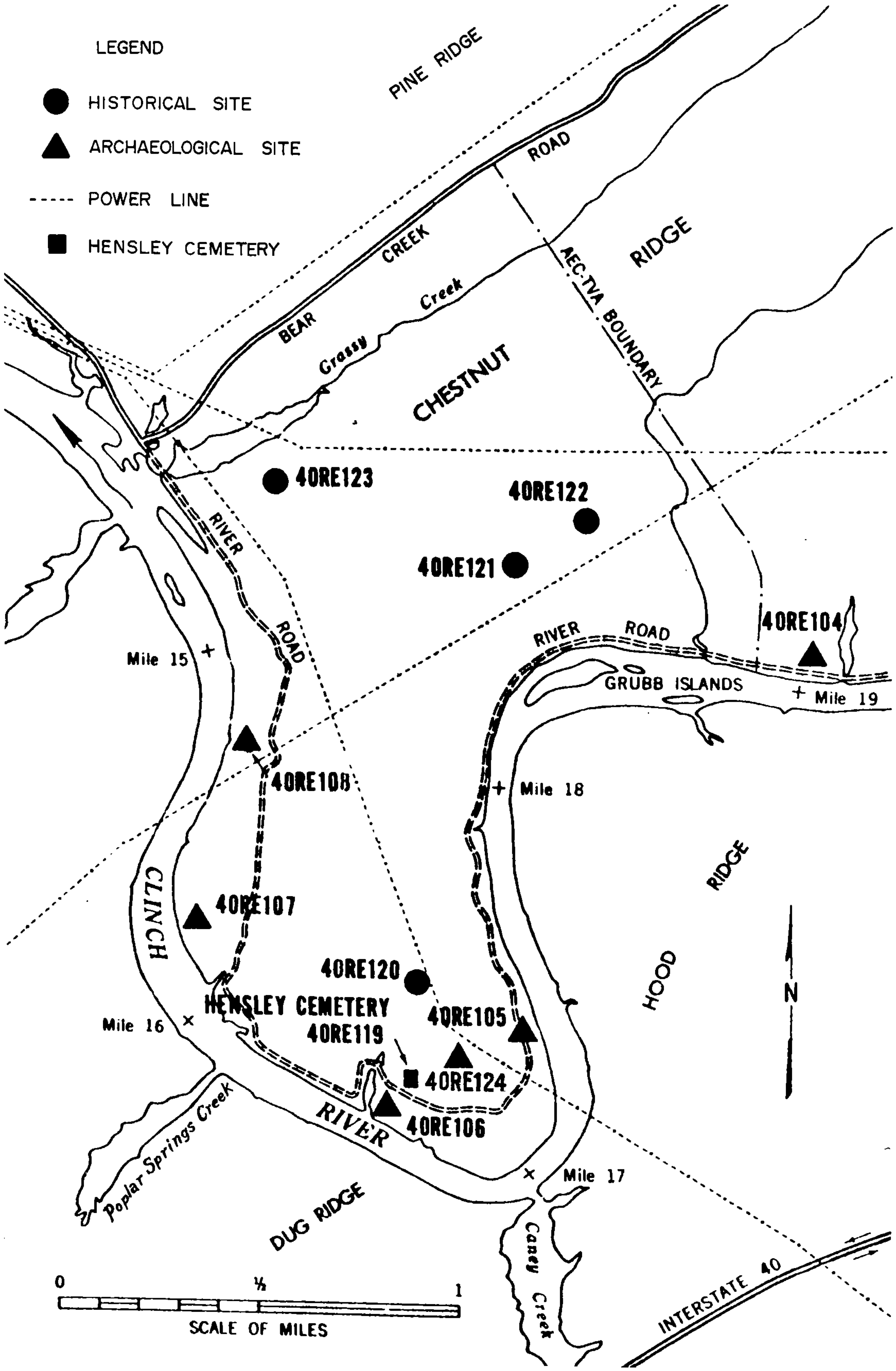


Figure 2.3-1 ARCHAEOLOGICAL AND HISTORICAL SITES

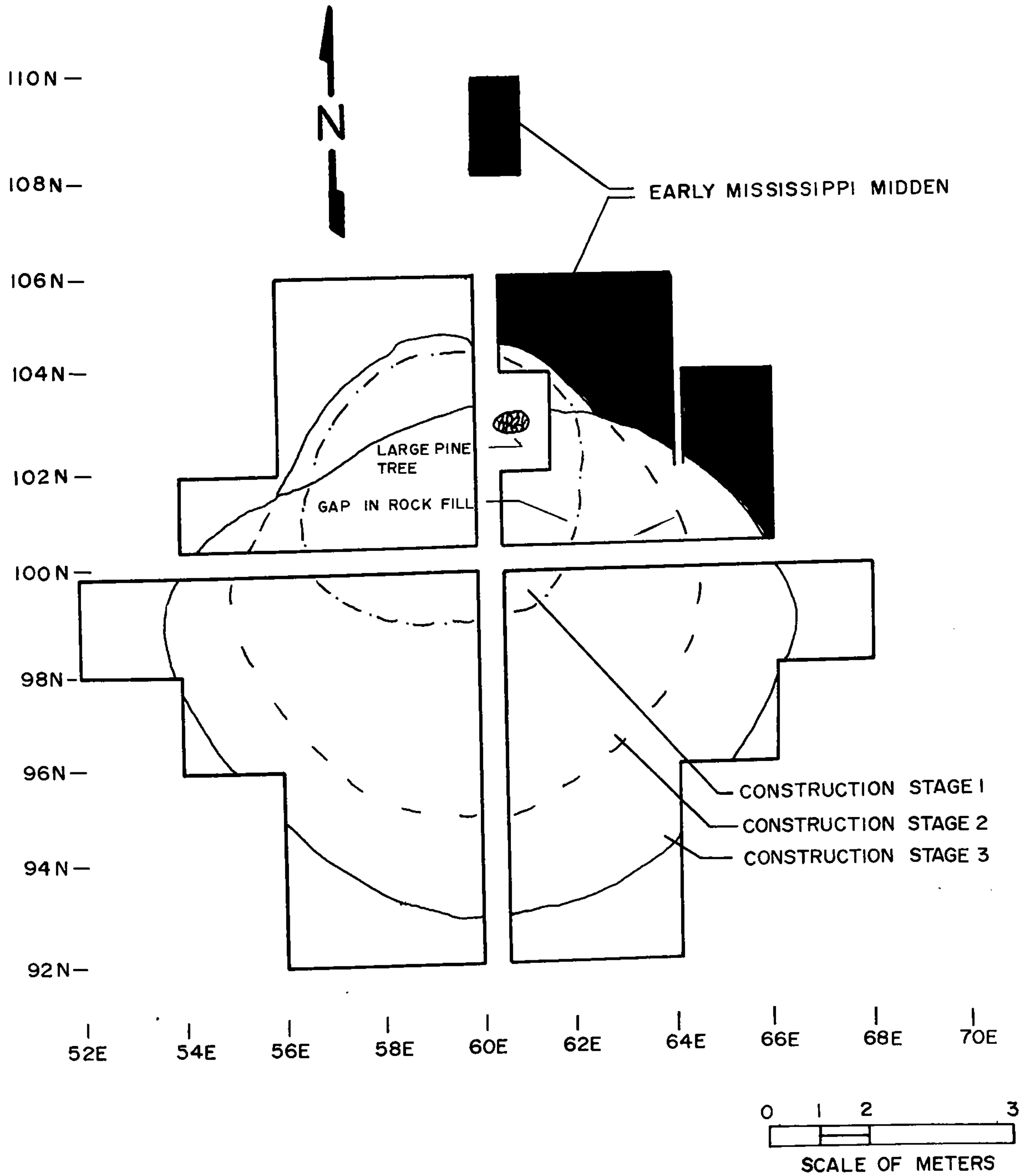


Figure 2.3-2 PLANVIEW OF EXCAVATIONS, MOUND CONSTRUCTION STAGES AND ADJACENT MIDDEN DEPOSITS (15)

2.4 GEOLOGY

2.4.1 GENERAL

Foundation investigations were conducted at the Clinch River Breeder Reactor Plant (CRBRP) Site during the periods of February 26 to March 17, 1972, October 25 to December 29, 1972, May 15 to June 25, 1973 and September 5 to April 15, 1974. The total investigative program for the Category I structures consisted of approximately 105 borings as indicated on Figure 2.4-1. These borings have been directed primarily to the completion of the grid pattern initiated by TVA in 1972 to define the Site geology, investigate sinkhole developments occurring in the general Site vicinity and locate the optimum location and bearing elevation for the Nuclear Plant Island including associated static and dynamic foundation design parameters. Other geologic studies included a detailed literature review,[1-10] surface mapping, remote sensing, seismic refraction and related geophysical cross-hole and hole-up surveys.

Investigations of the CRBRP Site have shown that the Site is underlain at shallow depths by sedimentary rocks of Ordovician age (more than 450 million years ago). Rock types in the immediate vicinity of the Site consist basically of siltstone and limestone with rock units occurring as wide, northeast trending bands. These units were deformed during the Paleozoic Era (more than 230 million years ago) and are now tilted to the southeast at an angle of about 30 degrees.[1,2] The Plant Island and Category I Emergency Cooling Tower, shown in Figure 2.4-2, will bear entirely within a siltstone band (Chickamauga, Unit A, Upper Siltstone) which was found to be the most suitable foundation stratum based on its resistance to weathering and its engineering properties. Category I structures incorporated in the Plant Island include the Containment Building, Reactor Service Building, Steam Generator Building, Intermediate Bay, Control Building, Diesel Generator Building and Auxiliary Bay.

2.4.2 GEOLOGIC HISTORY

2.4.2.1 REGIONAL

The CRBRP Site is located in the Appalachian Highland Physiographic Division of the eastern United States. Proximity of the Site to the physiographic provinces within the Appalachian Highlands is shown on Figure 2.4-3. As the name Appalachian Highlands implies, this area is presently characterized by rugged terrain which varies from rolling hills to mountains. Within 200 miles of the Site the physiographic provinces include Interior Low Plateaus, Appalachian Plateaus, Valley Ridge, Blue Ridge and Piedmont.

Early in the Paleozoic Era (600 million years ago), the location of the present Appalachian Highlands Physiographic Division was a geosyncline occupied by a mediterranean sea in which up to 40,000 feet of sediments accumulated. The sea was never that deep, but the sea floor subsided gradually under the weight of the sediments while the adjacent highlands rose. Some of the crustal movements that repeatedly occurred during the Paleozoic Era are recorded as unconformities which represent interruptions of the sedimentation process. The present Blue Ridge Physiographic Province coincides with the previous boundary between the deeper southern seas and the shallower northwestern portion of the geosyncline. In earliest Paleozoic time, the Piedmont Province was part of the geosyncline but eventually became a source area from which the sediments were derived to form the adjacent provinces.

Between middle and late Paleozoic time, several episodes of diastrophism occurred. Sediments southeast of the present Blue Ridge Province were injected with magmas and were severely deformed. Deformation of sediments north of the Blue Ridge was restricted to folding and major thrust faulting with no extensive metamorphism occurring. Toward the end of the Paleozoic Era the whole region was uplifted and has not since been submerged except for localized basins in the Piedmont during the Triassic Period (180 million years ago).

During the Mesozoic (63 to 230 million years ago) and Cenozoic Eras (present to 63 million years), erosion of the present Appalachian Mountains supplied the sediments that comprise the Coastal Plain formations.

During the Paleozoic Era, tectonic forces directed toward the northwest deformed the rocks of the Appalachian Geosyncline. Deformation was greatest in the southeastern portion (Piedmont and Blue Ridge) where the rocks were metamorphosed and injected by magmas. This portion was thrust to the northwest along boundary faults such as the Great Smokey Fault, shown in Figure 2.4-4. Rocks for several miles to the northwest of this boundary (Valley and Ridge) were shingled into a series of thrust blocks and as many as 10 of these blocks can be identified in Tennessee. The thrusting abruptly diminished toward the northwest where a broad syncline was developed (Appalachian Plateaus) and large lateral movements occurred along bedding.

There were several episodes of tectonic forces during the Paleozoic Era; however, one episode caused the major deformations of the rock strata in the vicinity of the CRBRP Site. This is referred to as the Allegheny Episode which occurred during the Pennsylvanian and Permian Periods, or at least 230 million years ago.

Regional geographic relationships are shown on Figure 2.4-5 which may be regarded as a bedrock map.

2.4.2.2 SITE GEOLOGY

The CRBRP Site lies near the western border of the Appalachian geosyncline. In Cambrian time, sands and clays were deposited in shallow muddy waters and these consolidated to form the sandstones and shales of the Rome Formation. The geosyncline gradually depressed and the sea became deeper and broader. At the beginning of the Conasauga deposition the sea received a small amount of sand and much clay. Sediment load gradually changed until the end of the Conasauga when only limy sediments were deposited. Throughout the succeeding Knox deposition, the sea was deep and still as indicated by the great thickness of limestones and dolomites that were deposited. At the close of the Knox deposition, the Site area was uplifted slightly and exposed to erosion. During the middle Ordovician, the land subsided again and was covered by a shallow and oscillating sea in which a great thickness of calcareous shale and limestone was deposited. It was at this time that the interbedded limestones, shaly limestones, calcareous shales and calcareous siltstones forming the Chickamauga Unit at the Clinch River Site were laid down. Silurian through Pennsylvanian deposition included sand, clay and limestone. At the end of Paleozoic time, during the Allegheny orogenic episode, the rocks at the Site were tilted to the southeast as thrust faults developed beyond the Site to the southeast and northwest. Since Paleozoic time, weathering and erosion have been the dominant geologic processes at the Site with sediment accumulation being restricted to terrace and flood plain deposits of the Clinch River. Site geology and physiographic relationships are shown on Figure 2.4-6 and are itemized in Table 2.4-1.[2,3]

2.4.2.3 PHYSIOGRAPHY

Geologic history of the Site has resulted in the present day topography which is characterized by subparallel ridges with intervening valleys as shown in Figure 2.1-5. The major ridges are Chestnut Ridge to the northwest and Dug-Hood Ridge to the southeast. Elevations of the ridge crests range between 900 and 1,200 feet. The valley separating these ridges is regionally referred to as Raccoon Valley and in the Site vicinity locally referred to as Poplar Springs Valley and Bethel Valley. This valley consists of rolling hills which range between elevations of 750 and 800 feet.

The CRBRP Site is a peninsula formed by a U-shaped bend of the Clinch River approximately between CRM 15 and 18. Within the Site boundaries Chestnut Ridge consists of two subordinate ridges which crest at about elevation 900 feet. These subridges are separated by a minor ravine which trends northeasterly across the peninsula. A topographic saddle in the bottom of this valley rises to about elevation 800 feet. The valley slopes from this saddle both in a northeasterly and southwesterly direction down to the level of the Clinch River (normal summer pool 741 feet). The sides of the valley slope upward at an inclination of about 12 degrees. Major directional control of the topography in the vicinity of the Plant Island is the northeasterly strike of the underlying rock strata. Rock bedding is inclined down to the southeast causing the various rock layers to occur as northeast-trending bands.

The Clinch River floodplain borders the western side and the southern tip of the peninsula, as shown in Figure 2.4-6. This floodplain is flat to gently sloping and extends up to about elevation 752 feet. Its maximum width is about 500 feet. The floodplain is essentially absent from the eastern border of the Site due to the presence of steep bluffs.

There are no perennial streams at the Site and flow along valleys and gullies occurs only after periods of heavy rainfall. Surface drainage from the Chestnut Ridge section of the Site occurs along northeast-trending ravines and reflects the control of the underlying rock strata. Drainage in the Poplar Springs Valley portion of the Site generally occurs in a more random pattern.

2.4.3 STRATIGRAPHY AND LITHOLOGY

Rock in the immediate vicinity of the Site is comprised of two major geologic units, the Knox Group and Chickamauga Group. Scattered rock outcrops occur in the central portions of the Site; however, the rock is generally covered by a veneer of residual soil, except in the southern portion of the peninsula and near the river where ancient terrace and recent alluvial soils have been deposited.

2.4.3.1 KNOX GROUP

The Knox Group is predominantly dolomite with lesser amounts of limestone and contains thick, chert-bearing sequences. The Knox overlies the Conasauga Group and is in turn overlain by the Chickamauga Group. The boundary between the Knox and Chickamauga is a disconformity formed by erosion of the Knox and subsequent deposition of the Chickamauga during the Ordovician Period.

Site borings penetrating the upper portion of the Knox Group encountered predominantly light to medium gray, crystalline dolomite. Pink and green shale laminations also occur in the core. Pockets of chert-bearing calcareous siltstone similar to the basal portion of the Chickamauga were encountered at the top of the Knox and represent sediments deposited in irregularities on the pre-Chickamauga erosion surface.

2.4.3.2 CHICKAMAUGA GROUP

The Chickamauga Group consists of alternating layers and laminations of maroon and gray siltstone, limestone and shale with thin layers and nodules of chert in the lower portion. The Chickamauga Group outcrops on the southeastern half of the CRBRP Site and is overlain by the Rome Formation to the southeast of the Clinch River. The boundary between these two formations is the Copper Creek Fault which truncates the upper portion of the Chickamauga. Total stratigraphic thickness of the Chickamauga at the Site is approximately 1,700 feet.

The lower portion of the Chickamauga is subdivided into Units A and B, as illustrated in Figure 2.4-7. Eleven key stratigraphic horizons within the Lower Chickamauga were previously determined by TVA and have been used as aids in determining the continuity and orientation of the Chickamauga.

2.4.3.2.1 UNIT A

Unit A is the basal portion of the Chickamauga and is subdivided into the Lower Siltstone, Unit A Limestone and Unit A Upper Siltstone. Unit A Lower Siltstone consists of alternating layers and laminations of maroon and gray calcareous siltstone, gray limestone and maroon, gray and black chert layers and nodules. Constituent percentages of the alternating layers of the Chickamauga Units are being determined by measurement of core samples and interpretation of geophysical logs. Siltstone constitutes about 60 percent of the Unit A Lower Siltstone. Mineralogy studies indicate the composition of the siltstone layers to be about 30 to 50 percent carbonate minerals (calcite plus dolomite), about 30 to 50 percent minute particles of disseminated silica (quartz plus chert) with the remainder being clay minerals. Iron oxide, up to about two percent, is also present and apparently imparts the maroon color to the siltstone. Limestone constitutes about 30 percent of the Lower Siltstone with the remaining 10 percent being chert. Mineralogy studies for the limestone layers indicate about 80 to 98 percent carbonate material and 2 to 10 percent clay minerals; the remainder of the samples consist of finely disseminated quartz. Thickness of the Lower Siltstone is variable because its lower boundary is an undulating disconformity at the top of the Knox Group. Its stratigraphic thickness from all borings made to date ranges between 152 and 209 feet, averaging about 176 feet.

Unit A limestone segment is light to dark gray limestone with laminations and layers of maroon and gray calcareous siltstone. About 75 percent of this segment is limestone. Chert nodules occur within the limestone and constitute about five percent of this segment. Mineralogy studies show that the limestone contains about 5 to 45 percent chert and clay mineral impurities. The thickness of the Unit A Limestone ranges from 76 to 85 feet in the borings made to date, averaging 81 feet.

Unit A Upper Siltstone, which comprises the foundation bearing stratum for the Nuclear Plant Island as shown in Figure 2.4-8, consists of maroon and gray calcareous siltstone with laminations and layers of gray argillaceous limestone. Siltstone constitutes about 80 percent of this unit. Argillaceous limestone occurs as thin laminations within predominant siltstone sections and as scattered layers up to a few inches thick. Mineralogy studies show that the siltstone contains about 35 to 50 percent carbonates (calcite and dolomite) and the argillaceous limestone contains about 50 to 70 percent carbonates. Stratigraphic thickness of the Upper Siltstone in the borings made to date ranges between 192 and 199 feet, averaging about 197 feet.

2.4.3.2.2 UNIT B

Unit B of the Chickamauga Group is light to dark gray limestone and argillaceous limestone which contains chert nodules. It contains laminations and layers of dark gray calcareous siltstone and is locally nodular and fossiliferous. Although no borings penetrated the entire Unit B sequence, its stratigraphic thickness is estimated to be 252 feet.

2.4.3.2.3 UNDIFFERENTIATED CHICKAMAUGA

Sequences of the Chickamauga Group above Unit B have not been differentiated in the same manner as the lower units during this investigation. A general description of the Undifferentiated Chickamauga is alternating maroon and gray limestone, shale and siltstone.

2.4.3.3 TERRACE AND ALLUVIAL DEPOSITS

Terrace deposits form veneer over portions of the Site as shown in Figure 2.4-6. This material is high-level alluvium deposited by the Clinch River when stream levels were much higher than at the present. Such deposits are generally regarded by geologists as Pleistocene or Pliocene. Terrace deposits consist mainly of orange and red silty clay with thin layers of rounded quartz, chert and quartzite gravel. No borings have penetrated the terrace deposits, but based on exposures and topographic occurrence, they are estimated to be less than 40 feet thick.

Alluvium underlies the Clinch River floodplain. One of the borings penetrated this deposit, encountering sand and clay to a depth of about 32 feet.

2.4.4 STRUCTURE

2.4.4.1 SITE STRUCTURE

The attitude of the bedding planes and joints at the CRBRP Site were calculated utilizing data obtained from surface mapping and by defining the orientation of key stratigraphic horizons traceable between borings (3 point solution). Interpretations of structural features are based on these data as well as observations of outcrops and rock core.

Outcrop measurements provided the general attitude of the rocks over the Site peninsula. In addition, small scale structural distortions were noted during surface mapping. From outcrop data, the rock bedding was measured to strike between north 35 degrees east and north 60 degrees east and dip to the southeast between 20 degrees and 52 degrees.

As can be seen from these measurements, the attitude of the rocks is quite consistent. However, small scale drag folds are common in these rocks and were also observed at the Site. Such features include tight folds or shears which extend over short distances -- a few inches to a few feet.

Bedding strike, based on stratigraphic keys, is between north 48 degrees east and north 60 degrees east and the dip is to the southeast between 24 degrees and 35 degrees. Average strike from stratigraphic keys is north 53 degrees east with a 30 degree dip to the southeast.

Minor undulations in the attitude of the lower Chickamauga units have been interpreted from stratigraphic keys observed in the rock core. Small drag folds and minor dislocations in the rock are common in the region and are present at the Site. In rock core obtained from Site investigation work, slickensided joint and bedding surfaces occur sporadically and an ancient rehealed shear zone can be distinguished in the lower portion of the Unit A Limestone. This shear zone is essentially a zone of interbedded slippage characterized by a combination of slickensides, calcite veins and one-inch to one-foot segments that are either severely warped or brecciated. It was encountered in 37 borings and ranges from 19 to 47 feet thick, averaging 35 feet thick.

Minor structures observed at the Site, including the interbedded slippage noted in the core, are common to the region and represent ancient adjustments (more than 230 million years ago).

2.4.4.2 NEARBY TECTONIC STRUCTURES

A tectonic structure is a large scale dislocation or distortion within the earth's crust with its extent measured in miles. Tectonic structures in the Valley and Ridge consist of numerous Paleozoic thrust faults and folds. The CRBRP Site is situated between the traces of two inactive tectonic structures: the Copper Creek and Whiteoak Mountain thrust faults, shown in Figures 2.4-9 and 2.4-10. Both of these faults have been investigated and it has been concluded that there is no reason to suspect any post-Paleozoic activity associated with them. Even though the inactive tectonic structures within the Valley and Ridge do not affect the determination of the Safe Shutdown Earthquake, they are discussed below.

2.4.4.2.1 COPPER CREEK FAULT

The Copper Creek Fault is mapped approximately 100 miles in length and the CRBRP Site is located near its mid-point. Shortest distance from the CRBRP Plant Island to the fault trace is about 3,200 feet, south. In the Site vicinity, the fault strikes north 52 degrees east and dips southeast (away from the Site) at an angle of about 27 degrees measured at the ground surface. Nearby borings indicate that the dip angle decreases with depth. In the Site area, the Copper Creek Fault has thrust the Rome Formation over younger rocks of the Chickamauga Group for a horizontal distance estimated to be in miles. The stratigraphic displacement is approximately 7,200 feet. About 65 miles southeast of the Site, the fault becomes a complex zone and merges with the Whiteoak Mountain Fault.

The trace of Copper Creek Fault was identified at several outcrop locations in the vicinity of the Site and in one of the site borings, as seen on Figure 2.4-9. Additional data was obtained from the Joy Test Well (JTW) which penetrated the Copper Creek Fault at a depth of about 2,370 feet.

Best exposure of the Copper Creek Fault near the Site is at the I-40 road cut about two miles southwest of the Site. At this location, the fault is an eight-inch mylonite layer. The hanging wall is a dark gray dolomite of the Rome Formation and the foot wall is a gray limestone of the Chickamauga Group. Except for minor undulations, the beds on both sides of the fault are undisturbed. The Rome beds strike north 55 degrees east and dip 35 degrees southeast; the Chickamauga beds strike north 53 degrees east and dip 29 degrees southeast. Apparent dip of the fault trace is 20 degrees, which implies a 27 degree dip for the fault plane at this location.

Representative samples of the mylonite and the adjacent hanging wall (Rome Formation) and foot wall (Chickamauga Group) of the Copper Creek Fault were obtained for age determinations. Whole rock potassium-argon dating gives an age of about 760 and 530 millions of years for the hanging wall and foot wall country rocks, respectively, as can be seen in Table 2.4-2. Age of the mylonite is about 285 million years. These dates confirm previous work of experts in the Valley and Ridge[1,3,5,10,11] and indicate that the last active period of Ridge and Valley tectonism was late Paleozoic.

2.4.4.2.2 WHITEOAK MOUNTAIN FAULT

Whiteoak Mountain Fault is composed of a main thrust fault and several subsidiary thrust faults branching from the main thrust. The fault extends southeasterly across the state from a point near Clinton, Tennessee, about four miles northeast of the Oak Ridge Reservation. Rome Formation (Cambrian) overlies younger rocks of Ordovician Age along the Fault. Nearest trace of the Whiteoak Mountain Fault system is two miles from the Site. The main fault and its subsidiaries dip to the southeast, at an inclination estimated to be 45 to 50 degrees, with the angle probably decreasing with depth. Data from outcrops and from a deep core hole drilled about four miles east of the CRBRP Site[12] indicate that the Whiteoak Mountain Fault and its subsidiaries are deeper than 2,000 feet at the Site.

2.4.5 SOLUTION ACTIVITY

Slightly acidic groundwater produces solutioning in carbonate rocks. Extent of solutioning is dependent upon their mineralogical composition. In areas where the rocks are limestones and dolomites, solutioning is severe. The degree of solutioning decreases as the rocks grade towards more siliceous and clayey sediments. In those sediments which do not contain carbonate materials, solutioning is negligible. Solutioning generally advances along structural features such as joints and bedding and advanced stages produce nearly planar zones which diminish in size with depth. Steeply inclined solution joints are often soil filled and are commonly referred to as slots. Solutioning of carbonate rock is expressed at the ground surface by surface depressions and dropouts commonly referred to as sinks, which generally result from ravelling of soil overburden into the underlying caves and slots. Shapes of the sinks are governed by the extent to which ravelling has progressed and the overburden thickness. Sinks vary in shape from nearly circular to elongated and in horizontal extent from a few feet to several hundred feet. In cross-section they vary from saucerlike to steepsided.

Sinkholes were noted in that portion of the Site where the Knox outcrops and in the southeast portion where the Units B and C of the Chickamauga outcrop. Sinkholes in these areas occur as: (1) small diameter vertical holes less than one foot; (2) asymmetrical depressions which are generally less than 100 feet across and 10 to 15 feet deep; and (3) gentle sided depressions which are several hundred feet across and 10 to 15 feet deep, as shown on Figure 2.4-6. Only a few small-diameter vertical holes were noted in the outcrop area of the Unit A Limestone. No evidence of sinkhole formation was noted in the Unit A Upper Siltstone stratum.

2.4.6 PHYSICAL CHARACTER OF THE ROCKS

Rock at the Site weathers to clayey residual soil which locally contains chert gravel. Depth of soil varies from one foot to 56 feet in borings in the Plant Island vicinity and is a maximum of 78 feet deep in the northeastern portion of the Site. Unit A Upper Siltstone residuum ranges from one foot to 29 feet deep in the borings and soil depths over the Unit A and B Limestones range from 12 to 54 feet and 8 to 56 feet, respectively. Soil overburden above the Unit A Lower Siltstone is 11 to 39 feet deep.

Northwest of the plant structures the Knox dolomite occurs and is covered with overburden ranging from two to 78 feet in the borings.

Weathering within the rock occurs as solution widening of joints and bedding features. In areas where the limestones and dolomites outcrop, rock weathering along joints is the greatest (zero to 73 feet below top of rock). In areas where Upper Siltstone outcrops, rock weathering is minimal (zero to 57 feet). The top of continuous rock has been defined as rock which does not contain any significant weathered or solutioned discontinuities.

Topography of the Site is governed by the rock types and their resultant residual soil cover. Unit A Upper Siltstone residuum is a readily erodible soil type which results in a thin soil cover. A small valley has developed through this easily erodible material. In this unit, sound and continuous rock, free of significant weathering and solutioning, occurs within at least about 43 feet of the ground surface in the outcrop area.

The slope immediately northwest of the previously discussed valley is underlain by the Unit A Limestone. In this area, the clay residuum is more resistant to erosion resulting in the thicker overburden above the limestone. In the Unit A Limestone outcrop area, the limestone has undergone weathering and solutioning along joints and partings to a maximum depth of about 100 feet. Unit A Limestone dips beneath the impermeable Upper Siltstone near the bottom of the valley. Where the limestone is covered by the impermeable siltstone, the borings indicate that significant weathering and solutioning have not occurred.

Along the southeast limits of the plant structures, the ridge is underlain by the Unit B Limestone. Overburden thickness in this area extends to similar depths as the limestone area discussed above (8 to 56 feet deep). Weathering and solutioning of the underlying limestone has extended to a maximum depth of about 100 feet. Below this depth, joints penetrated by borings do not indicate any significant weathering or solutioning.

Unit A Lower Siltstone outcrops on the crest and the northern flank of the ridge northwest of the small valley. In this area the depth of overburden extends to a maximum of about 37 feet. Rocks which consist of siltstone and limestone have undergone weathering and solutioning to a depth of about 85 feet below top of rock. Depth of maximum weathering and solutioning corresponds to mean sea level (MSL) elevations of about 750 to 850 feet. Toward the southern extremity of the Lower Siltstone outcrop bank, a small anticlinal fold occurs. Within the anticlinal area, the rock is apparently more extensively jointed, facilitating deeper weathering. Maximum depth of weathering and solutioning within this anticlinal area is 108 feet, corresponding to an approximate elevation of 704 feet MSL.

The Knox Group outcrops on the northwest flank of the ridge northwest of the small valley. The most prominent feature of the Knox outcrop zone is a bank of sinkholes which are generally aligned along the bedding plane strike. Borings, which penetrated through the lower Chickamauga strata into the Knox Group, did not encounter any weathering or solutioning at the Knox contact or within the Knox.

The soil-rock profile for inclined strata of limestone and dolomite is typically quite irregular, exhibiting rock pinnacles and intervening gaps. These irregularities are developed by solution-widening along joints and to a lesser extent along bedding. A wide range of soil depths over the Knox Group, Chickamauga Unit A Limestone and Chickamauga Unit B Limestone reflects these irregularities. Weathering has advanced from the surface along joints and partings in the rock to produce soil seams and cavities that range from less than one inch to 14 feet in the borings. Frequency and size of soil seams and cavities produced by weathering and solutioning diminish with depth. Occurrence of such discontinuities is dependent on the surface exposure of the individual limestone units and joint frequency.

Ranges of static properties by preliminary laboratory testing of rock and in situ testing in base holes obtained from the upper siltstone stratum at the Site are as follows:

1. Unconfined compressive strength - 1,500 to 12,000 psi;
2. Young's modulus - 3×10^5 to 3×10^6 psi;
3. Dry unit weight - 150 to 170 pcf; and
4. Moisture content - 0.1 to 3.3 percent.

Dynamic properties of the rocks were determined by measuring the velocity of compression and shear waves. Three test methods were used in order to evaluate the range of velocities. The methods were as follows:

1. Continuous velocity borehole logging;
2. Seismic up-hole surveys; and
3. Seismic cross-hole surveys.

Preliminary results of the cross-hole velocity measurements are provided in Table 2.4-3. Dynamic properties evaluated include Bulk Modulus of Elasticity, Young's Modulus of Elasticity, Shear Modulus of Elasticity and Poisson's Ratio.

TABLE 2.4-1

STRATIGRAPHIC UNITS - VICINITY OF CRBRP SITE

CRBRP PROJECT

Era	Period	Epoch	Geologic Unit	Thickness Feet	Description and Location
Cenozoic	Quaternary	Recent	Recent Alluvium	Less than 40	Clay, sand and gravel Located in flood plain along river
Cenozoic	Quaternary	Pleistocene	Ancient Terrace Deposits	Less than 40	Dessicated clay, sand and gravel. High level ancient stream deposits, above recent flood plain
Cenozoic	Tertiary	Pliocene	Ancient Terrace Deposits	Less than 40	Dessicated clay, sand and gravel. High level ancient stream deposits, above recent flood plain
Paleozoic	Ordovician	--	Chickamauga Formation	1,700*	Gray limestone and shale, maroon calcareous siltstone and shale underlies south-eastern half of Site
Paleozoic	Ordovician Cambrian	--	Knox Group	3,000	Gray dolomite, contains nodules and layers of chert. Underlies northwestern half of Site

(Continued)

TABLE 2.4-1 (Continued)

Era	Period	Epoch	Geologic Unit	Thickness Feet	Description and Location
Paleozoic	Cambrian	--	Conasauga Group	1,500	Gray and brown shale and siltstone, with limestone. Borders Knox Group to the northeast (no outcrops within site limits)
Paleozoic	Cambrian	--	Rome Formation	800**	Maroon, tan and brown siltstone, sandstone and shale, with minor dolomite. Borders Chickamauga formation to the southeast of Site

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* Formation is thicker than indicated but upper portion was truncated by Copper Creek Fault.

**Formation is thicker than indicated but lower portion was truncated by Copper Creek Fault.

TABLE 2.4-2

RADIOMETRIC AGE DETERMINATIONS

CRBRP PROJECT

Sample and Location	Radiometric Age (Million Years)
Copper Creek Fault Mylonite I-40 Roadcut (southside) (Sample No. 1)	290 ± 10
Copper Creek Fault Mylonite I-40 Roadcut (southside) (Acid insoluble residue of Sample No. 1)	280 ± 10
Chickamauga Formation Limestone Sample I-40 Roadcut (southside) (near Sample No. 1)	530 ± 30*
Rome Formation Dolomite Sample I-40 Roadcut (southside) (near Sample No. 1)	760 ± 40*
Mylonite - from Faulted Diabase Dike - Lanford Mine, South Carolina, S. C. State Hwy. 49 and I-26	Approximately 150

*The Radiometric Age determined is for detrital material in sample and represents the age of the source (parent) material rather than the age of deposition or faulting.

TABLE 2.4-3

PRELIMINARY TABULATIONS - COMPRESSIONAL AND SHEAR WAVE VELOCITIES AND ELASTIC MODULI CALCULATIONS AT THE CRBRP SITE*

Geologic Material	Average "P" Wave Velocity (ft/sec)	Average "S" Wave Velocity (ft/sec)	Unit Weight (lbs/ft^3)	Poisson's Ratio	E_{seis} Young's Modulus (lbs/in^2 x 10^6)	G_{seis} Shear Modulus (lbs/in^2 x 10^6)	K_{seis} Bulk Modulus (lbs/in^2 x 10^6)
Siltstone	15,470	6,760	165	0.382	4.50	1.63	6.35
Limestone	18,380	8,380	165	0.369	6.85	2.50	8.70

*33 Series drill hole array

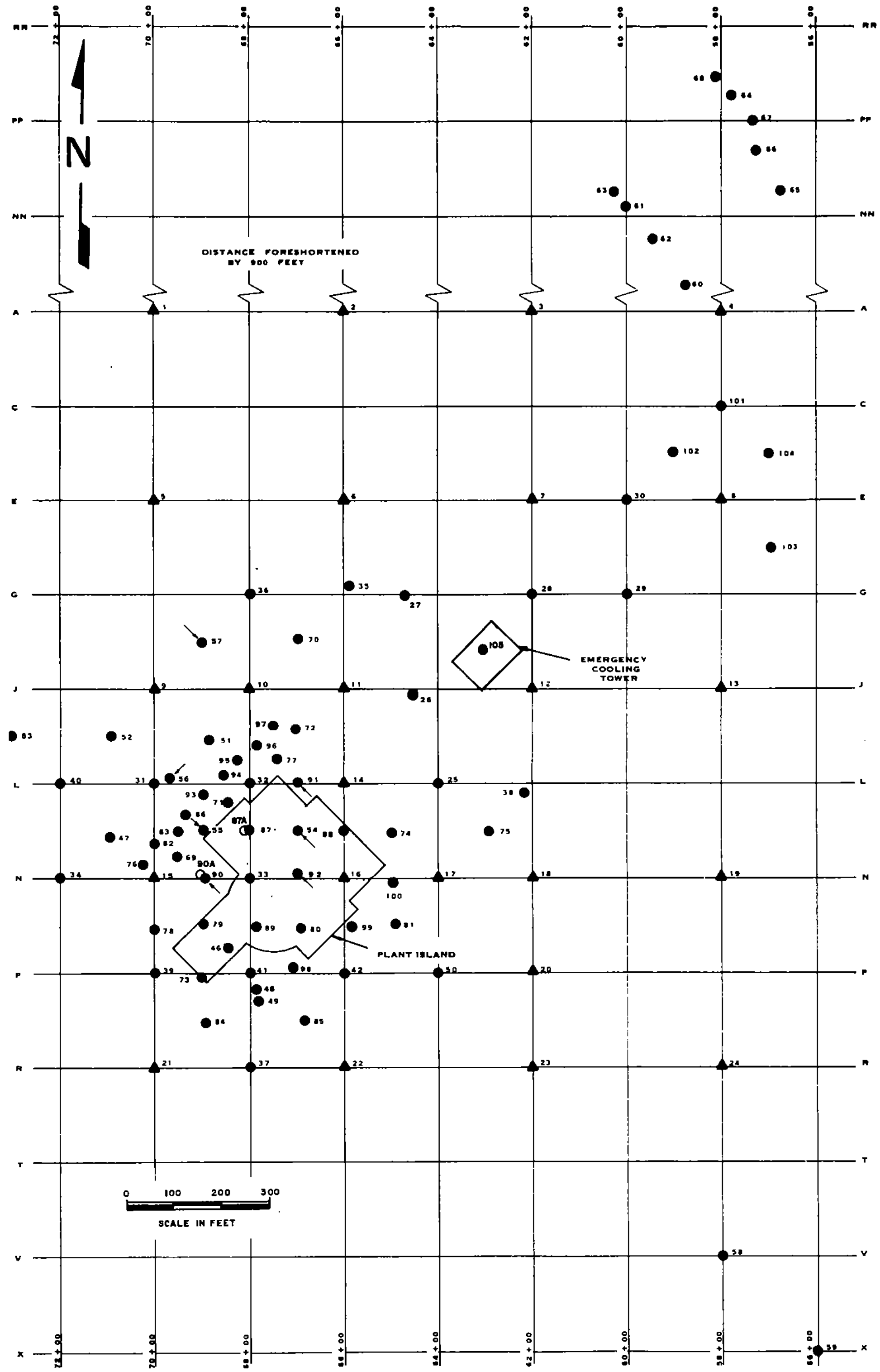


Figure 2.4-1 TEST BORING LOCATIONS AT CRBRP SITE

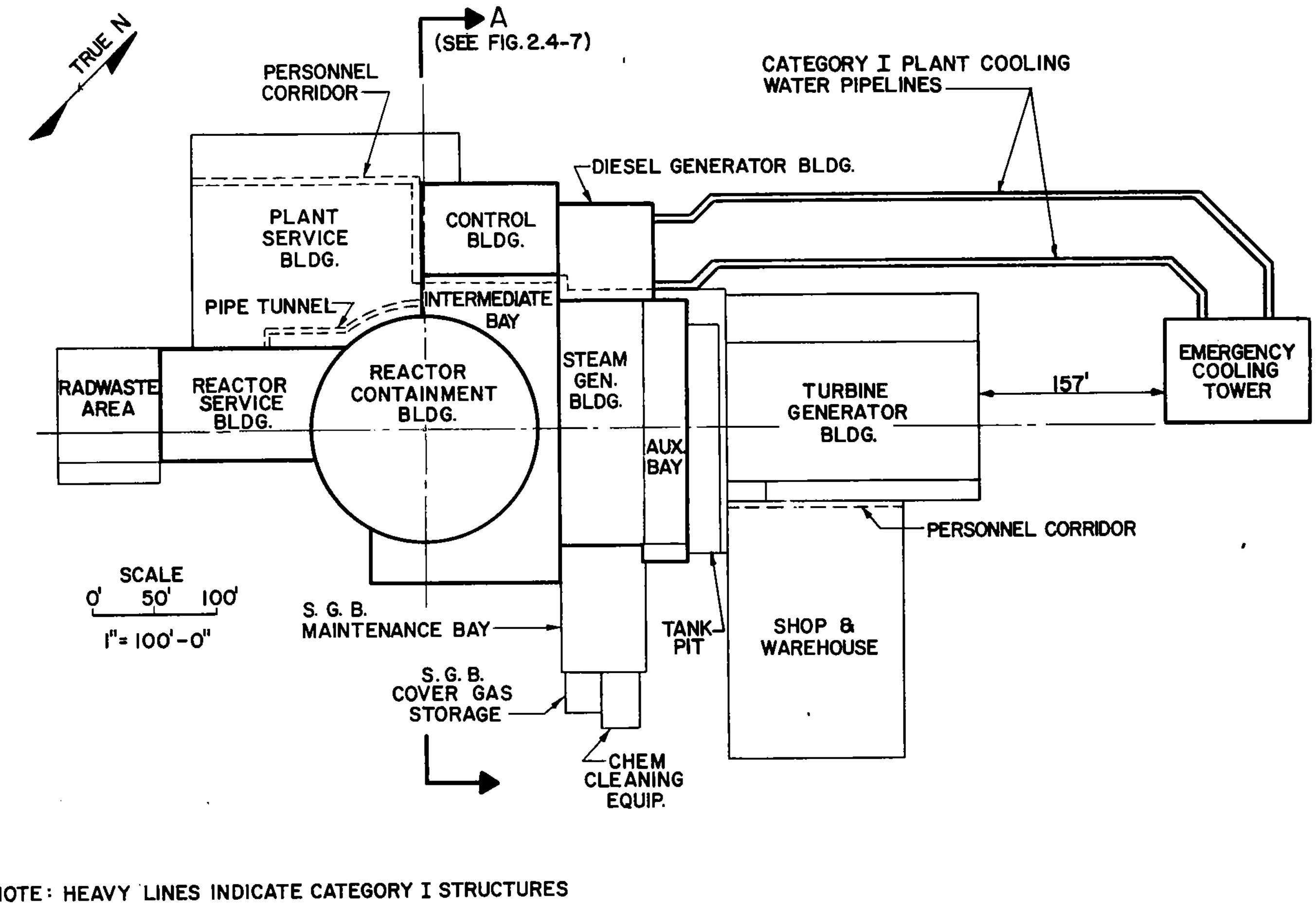


Figure 2.4-2 PLAN OF CRBRP ISLAND STRUCTURES AND CATEGORY I COOLING TOWER

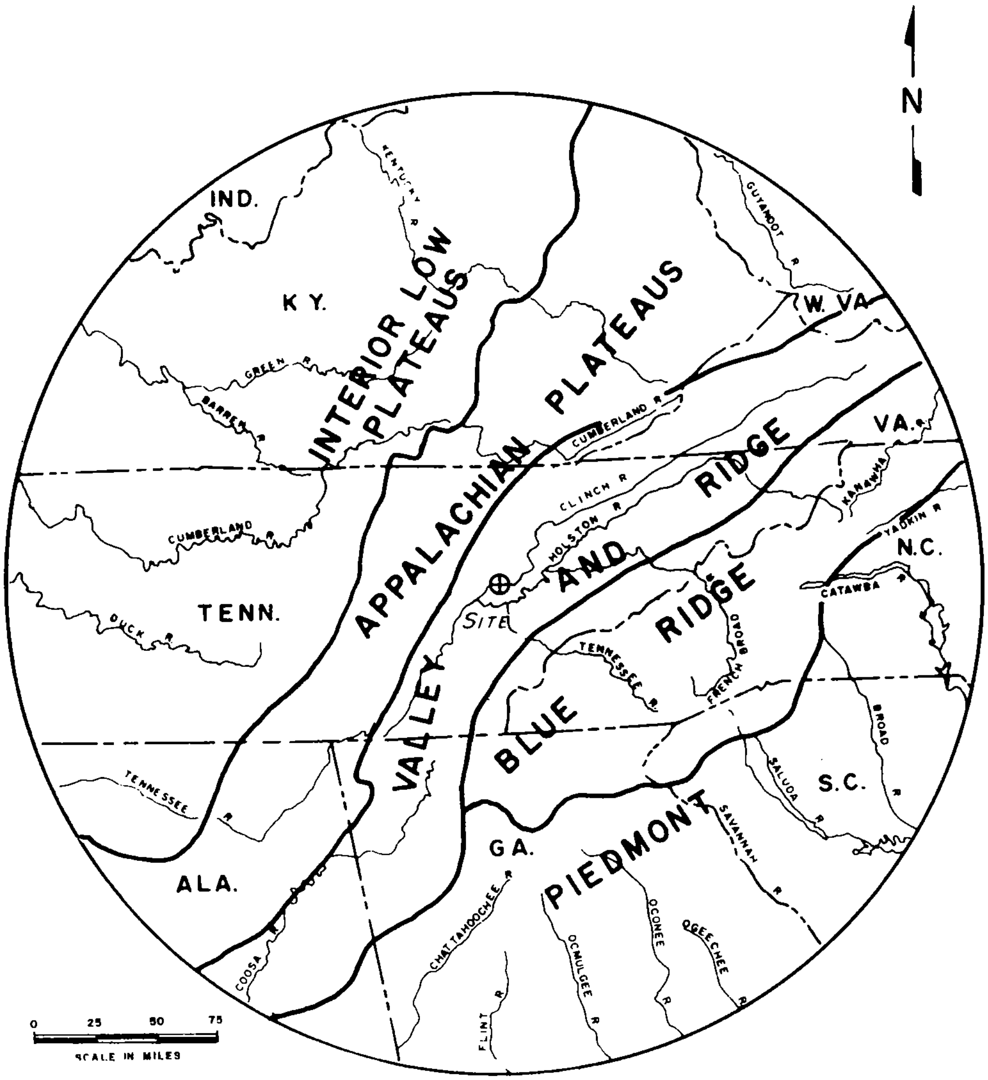


Figure 2.4-3 REGIONAL PHYSIOGRAPHIC MAP OF CRBRP SITE(13)

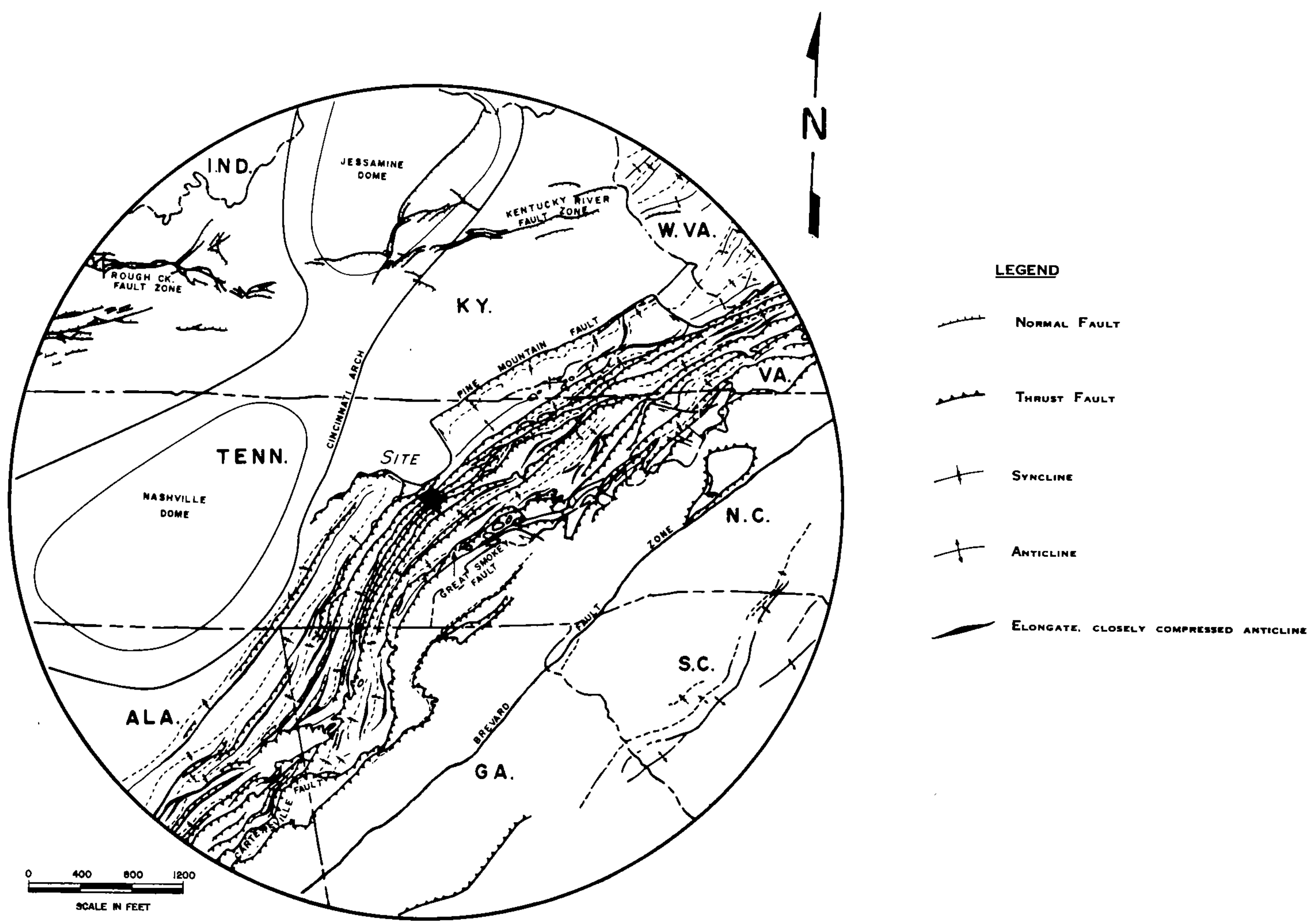


Figure 2.4-4 REGIONAL TECTONIC MAP OF CRBRP SITE[14]

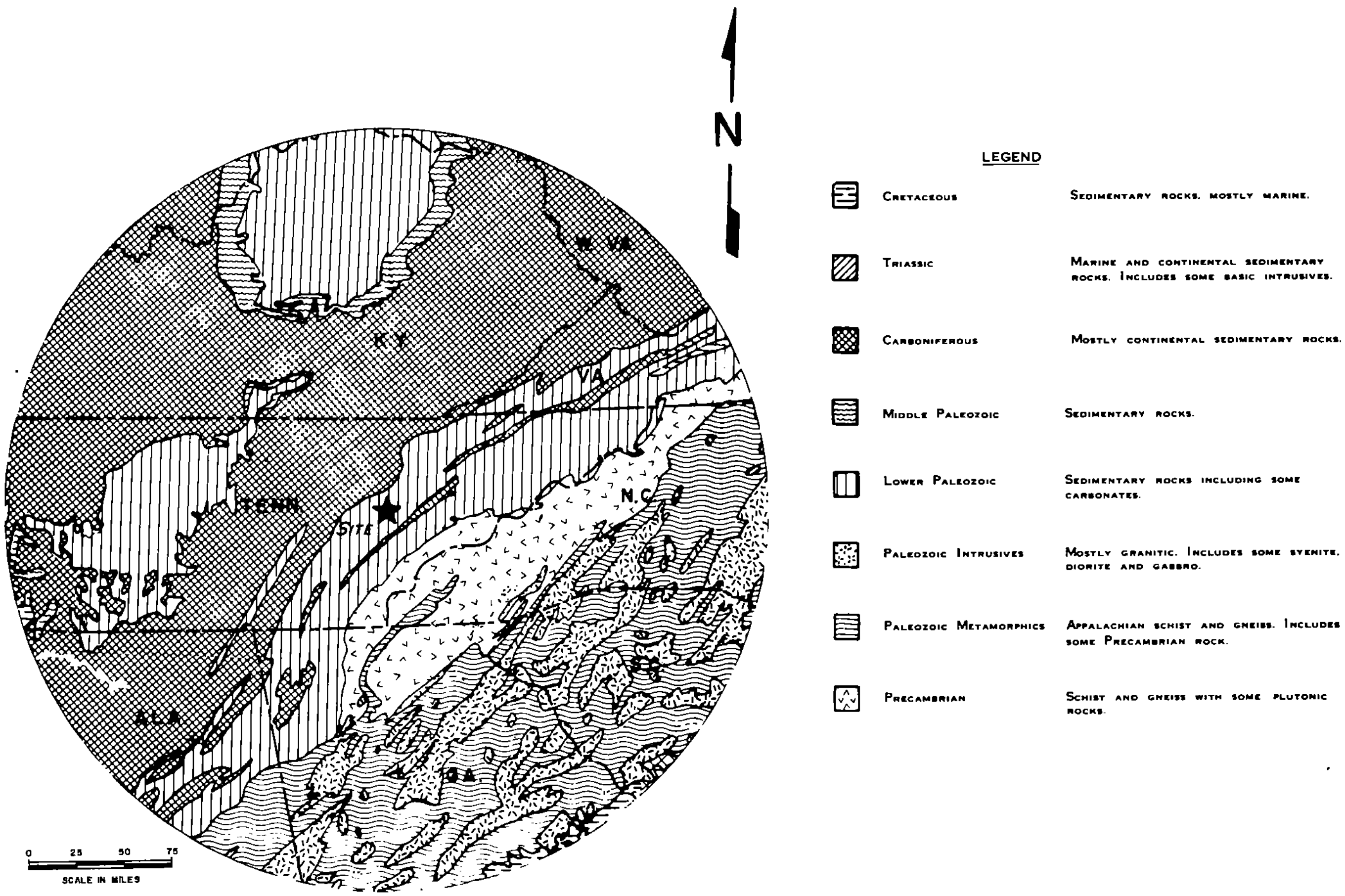


Figure 2.4-5 REGIONAL GEOLOGIC MAP OF CRBRP SITE[15]

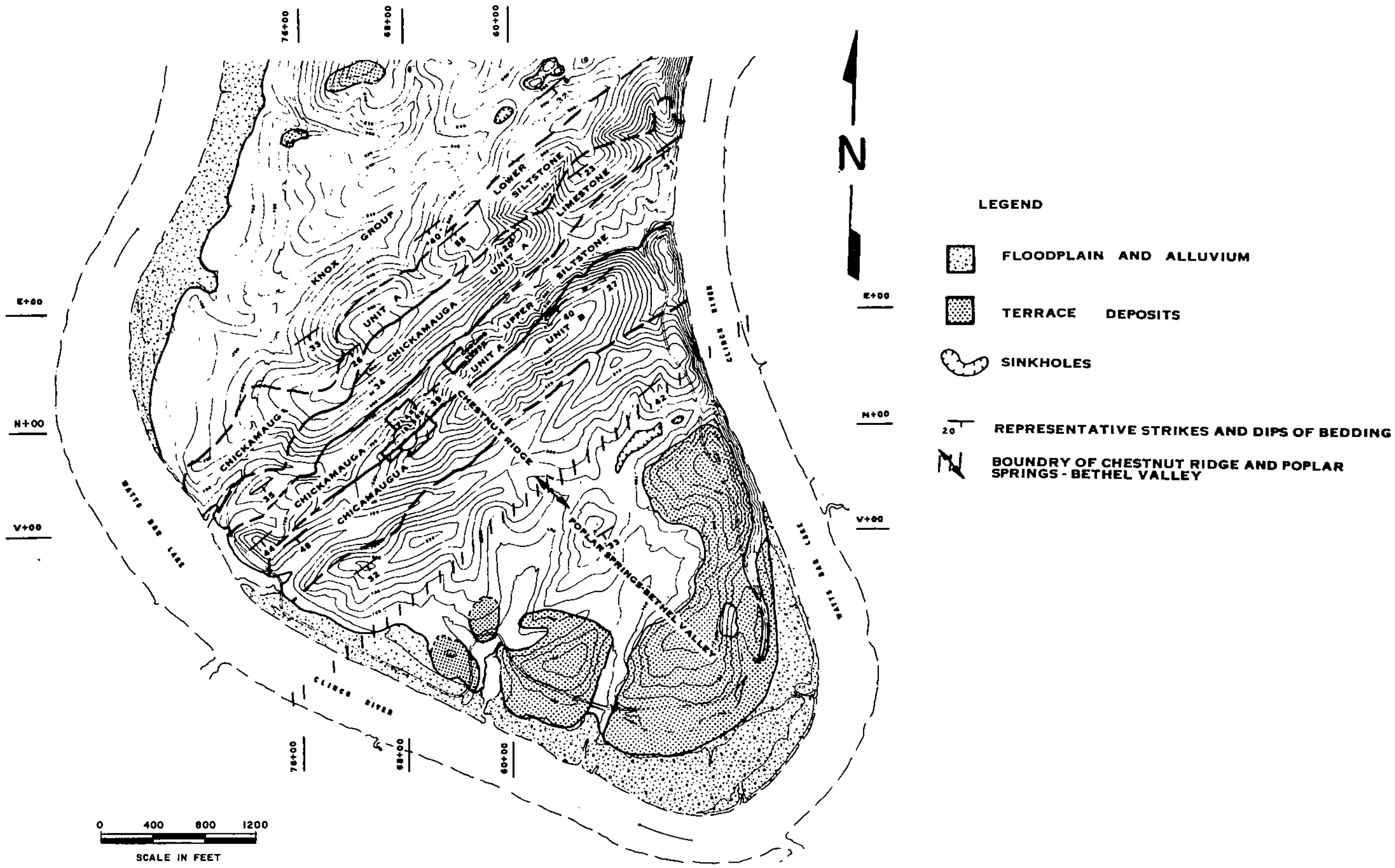


Figure 2.4-6 GEOLOGIC AND PHYSIOGRAPHIC MAP OF THE CRBRP SITE

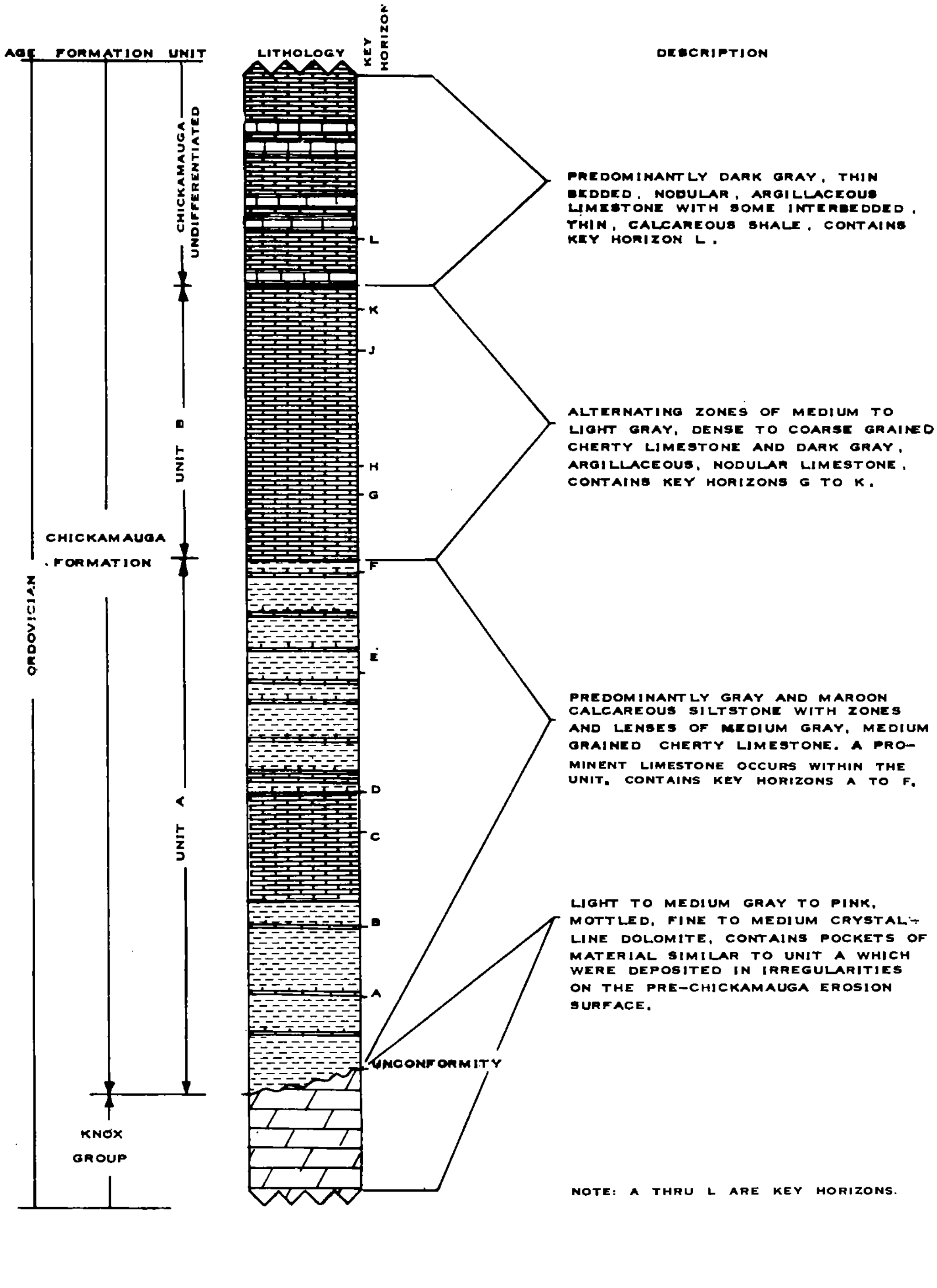


Figure 2.4-7 STRATIGRAPHIC SECTION AT SITE OF CRBRP PROJECT

KEY	DESCRIPTION
A	Black chert horizon containing red jasper specks. Lowest key in the Chickamauga.
B	Definite contact between maroon siltstone and mottled limestone.
C	Top of prominent fossiliferous zone.
D	Contact between siltstone and limestone portions of Unit A.
E	6" siltstone horizon between two limestone horizons.
F	Contact between greenish-gray and maroon siltstones near top of Unit A.
G	Contact between thin bedded, laminated limestone and nodular, irregular-bedded limestone.
H	Base of prominent unit of medium gray, coarse-grained massive limestone sandwiched between two zones of thin bedded, dark limestones.
J	Contact between dark, thin bedded, shaly limestone underlain by light gray, thin-bedded limestones.
K	Base of finely speckled fossiliferous zone.
L	Contact between irregular bedded light gray to dark gray banded limestone underlain by dark thin bedded limestone.

Note: These eleven key stratigraphic horizons were identified (TVA, 1972 at the CRBRP site for the purpose of determining areal strike and dip of the strata and for correlating between drill holes.

Figure 2.4-7 STRATIGRAPHIC SECTION AT SITE OF CRBRP PROJECT - KEY

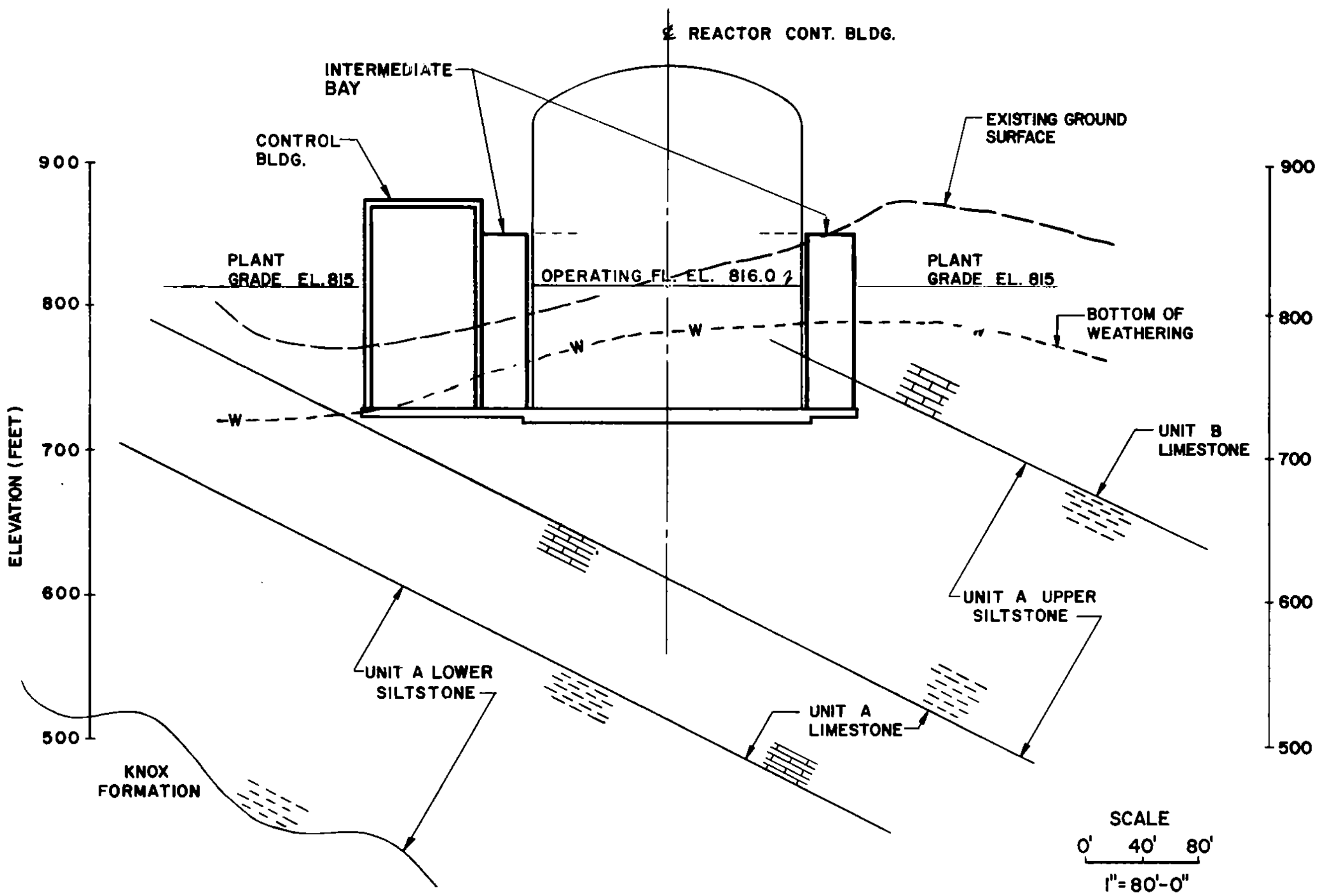


Figure 2.4-8 SECTION THROUGH CRBRP ISLAND AND FOUNDATION STRATA

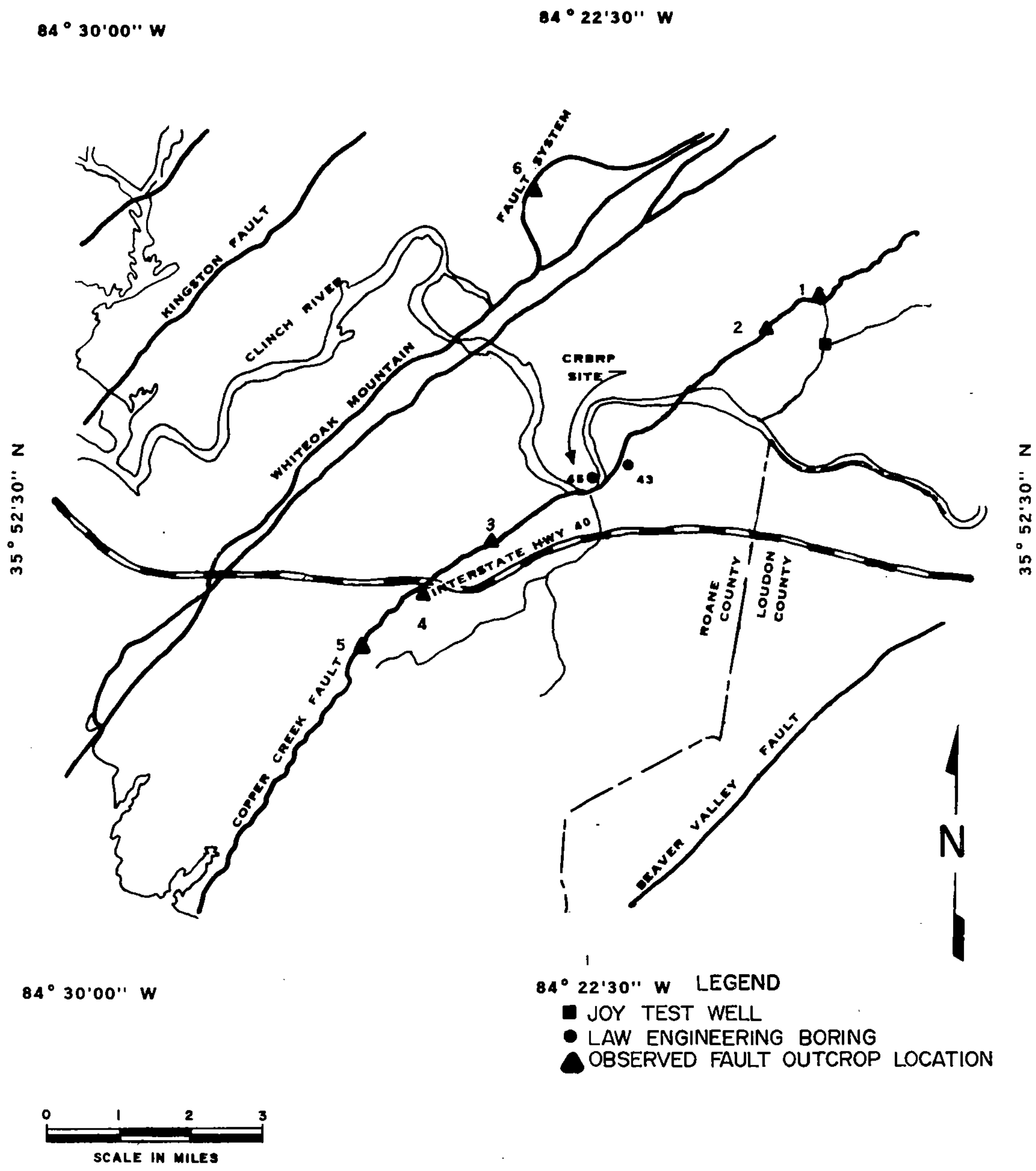


Figure 2.4-9 AREA STRUCTURE MAP IN THE CRBRP VICINITY

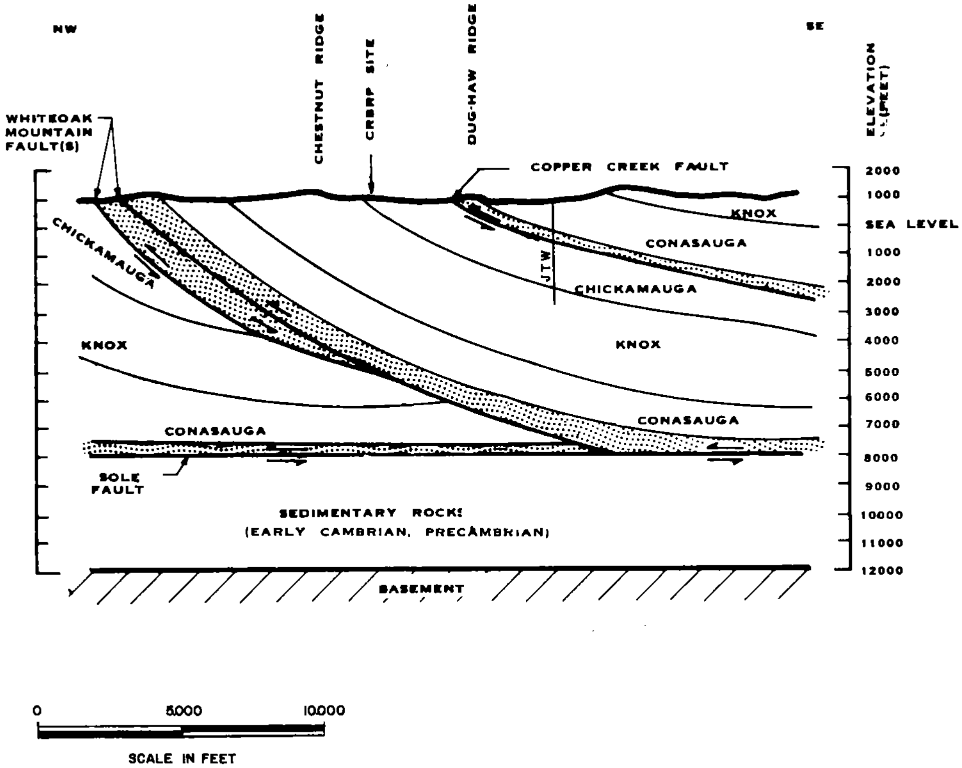


Figure 2.4-10 AREA GEOLOGIC CROSS SECTION CRBRP PROJECT

2.5 HYDROLOGY

2.5.1 SURFACE WATER

The Site is located on a peninsula formed by a meander of the Clinch River between river miles 14.5 and 18.6. Headwaters of the Clinch River are in Tazewell County, Virginia, about 175 airline miles northeast of the Site. From its headwaters, the Clinch River flows approximately 350 river miles in a southwesterly direction to its confluence with the Tennessee River at Tennessee River Mile 567.8, near Kingston, Tennessee. The river basin lies in the Valley and Ridge physiographic province, discussed in Section 2.4, which is characterized by comparatively narrow parallel ridges and somewhat broader intervening valleys lying in a northeast-southwest direction. Northwestern boundary of the basin is formed by the Cumberland Mountains which range up to 4,200 feet above sea level; the southeastern boundary follows Clinch Mountain and Black Oak Ridge with elevations ranging up to 4,700 feet. Forests cover approximately half the land area of the river basin. Slope of the Clinch River bed from Norris Dam at Clinch River Mile (CRM) 79.8 to CRM 7 averages about one and one-half feet per river mile, including the lift of Melton Hill Dam.[1] Water level of the Clinch River at the Site is approximately 741 feet above mean sea level (MSL). Plant grade will be at 815 MSL, placing the CRBRP about 74 feet above the water level of the river.

Topography of the Site, as shown in Figure 2.5-1, is characterized by a series of parallel ridges separated by long, narrow valleys extending in a northeast-southwest direction. There are no perennial streams on the Site; however, after a heavy rain, surface water flows from the ridges into valleys and gullies which drain into the river. Drainage area is 3,368 square miles at CRM 17.8 and 3,380 square miles at CRM 15.5.[2] It is not anticipated that construction of the CRBRP will alter the drainage pattern of the Site.

2.5.1.1 TRIBUTARIES

Major tributaries of the Clinch River are the Powell and Emory Rivers. The Powell River, which parallels the Clinch River about 10 miles to the north throughout most of its length, joins the Clinch River at CRM 88.8. Drainage area at the mouth of the Powell River is 938 square miles. The Powell River enters the Clinch River above Norris Dam; therefore, annual average flow and peak flood data from the Powell River are not applicable to the Site. The Emory River, with a drainage area of 865 square miles, enters the Clinch River southeast of Harriman, Tennessee, at CRM 4.4. Annual average flow of the Emory River is 1,590 cfs and the peak flow, occurring on March 23, 1929, was estimated as 195,000 cfs at the mouth.

Three minor tributaries which enter the Clinch River between Norris Dam and Melton Hill Dam are Beaver Creek, Bullrun Creek and Hinds Creek. These three streams enter from the south at CRM 39.6, 46.7 and 65.8, respectively.(1) Annual average flows and peak flood data for these creeks are not applicable to the Site because they enter the Clinch River above Melton Hill Dam. Poplar Creek, a minor tributary below Melton Hill Dam, enters the Clinch River from the north at CRM 12.0. The average annual flow of Poplar Creek is 260 cfs and drainage area at the mouth is 136 square miles.

Several other small streams and sloughs enter the Clinch River near the Site; however, they are not considered to be significant tributaries from the standpoint of water flow contribution to the Clinch River. Caney Creek which enters from the south at CRM 17 has a drainage area at the mouth of 8.27 square miles and an average flow of 14 cfs. Poplar Springs Creek at CRM 16.2 has a drainage area of 3.01 square miles at the mouth and an average flow of 5 cfs. Grassy Creek entering from the north at CRM 14.5 has a drainage area of 1.95 square miles and an average flow of 3 cfs. The combined average flows of these creeks total 22 cfs which is only 0.5 percent of the Clinch River flow at the Site.

2.5.1.2 WATER FLOW

Stream gages had been maintained by the U. S. Geological Survey on the Clinch River at the three locations listed in Table 2.5-1. Gages were maintained at these locations for various time periods from 1936 through 1968.(3,4,5,6) At the present time, no stream gages are being operated in the vicinity of the Site.

Based upon these stream gage records from the three locations, the average flow of the Clinch River was 4,561 cfs.(3,4,5,6) The maximum discharge during the period was 42,900 cfs and occurred on February 9, 1937,(5) before the closing of Melton Hill Dam. Based on discharge records from Melton Hill Dam since the closing in 1963, the average annual flow is about 4,800 cfs at the Site.(7) The maximum hourly average release was 43,400 cfs and the maximum daily average release was 26,900 cfs; both occurred on March 16, 1973 at Melton Hill Dam.(7)

2.5.1.3 HISTORICAL LOW FLOW

AEC Regulatory Guide 4.2 requests that the observed 7-day 10-year low flow value be provided. This value is not applicable since the Tennessee and Clinch Rivers are "controlled" rivers.

In the TVA system, requirements for power generation, navigation and flood control have established the basis for control of minimum water levels of the Clinch River at the Site. Regulation of low flows and water elevations at the Site is accomplished by controlled releases from Norris, Melton Hill, Fort Loudoun and Watts Bar Reservoirs. These reservoirs, shown in Figure 2.5-2, store large volumes of water and the controlled releases alter the natural flow patterns in the river system. In fact, historical low flows at the Site have resulted from regulated rather than from natural flows.

Since the closure of the dam in 1963, there has been an average of about 46 days per year on which no water was released from Melton Hill Dam. The longest period of no release was 29 consecutive days, as shown in Table 2.5-2. This occurred during February and March of 1966.[8] The second longest period of zero release from the dam was 11 consecutive days which occurred in the April-May period of 1967.[8] Both zero release periods resulted from special reservoir operations conducted to aid in controlling the growth of Eurasian water milfoil in the Melton Hill Reservoir. Such extended periods of zero flow from Melton Hill Dam are not anticipated in the future. Should the need arise for any regulation at Melton Hill Dam which would result in long periods of zero release, the operations would be coordinated to meet flow requirements at the CRBRP Site.[9]

Average monthly turbine and gate discharges from Melton Hill Dam for the years 1963 through 1973 are shown in Table 2.5-3. Daily average gate and turbine releases from the dam for the year 1973 are shown in Table 2.5-4. A flow duration curve of the discharges from the dam for the water years 1968-1972 is shown in Figure 2.5-3.

2.5.1.4 RESERVOIR WATER LEVELS

The Site is located on an arm of the Watts Bar Reservoir which extends up the Clinch River. Thus, the water elevation at the Site is influenced by the operation of Watts Bar Dam. Elevation at the bottom of the Clinch River channel at the Site ranges between 719 and 720 feet above mean sea level (MSL). Water depth at the Site is equal to or greater than the difference between the pool elevation at Watts Bar Dam minus this bottom elevation as can be seen in the downstream profile of the Clinch River, Figure 2.5-4. Bathymetric charts of the Clinch River in the areas of the intake and the discharge are shown in Figure 2.5-5 and 2.5-6, respectively. Cross-sectional profiles of these areas are shown in Figures 2.5-7 and 2.5-8, respectively.

Watts Bar Reservoir is a multiple-purpose reservoir providing power generation, navigation aid and flood control. TVA generally maintains a pool elevation between 740 and 741 MSL during the spring and summer months (mid-April through September) and a winter pool elevation of 735 to 737 MSL for the remainder of the year.

During the 32 years of record since the initial filling of Watts Bar Reservoir, TVA has been able to follow closely the above plan of normal operation. Sufficient inflow has been available each year to raise the reservoir from winter level to summer level on schedule. The water surface elevation at the Site is normally one to two feet higher than the level measured at Watts Bar Dam as a result of backwater. Since 1942, the minimum elevation of Watts Bar Reservoir was 733.44 MSL and occurred on March 20, 1945.(7) A maximum elevation of 745.40 MSL occurred on March 17, 1973.(8) Figure 2.5-9 shows the normal operating level for Watts Bar Reservoir. Table 2.5-5 shows the monthly maximum, minimum and average Watts Bar Reservoir elevations for the period 1962-1973.

Releases from Norris and Melton Hill Reservoirs, both upstream of the Site on the Clinch River, can be used to regulate flows at the Site. Although Norris Dam is the prime regulator of flow, Melton Hill Dam can influence low flows at the Site. Normal minimum pool stage at Melton Hill Reservoir is 790 MSL.(7)

Norris Reservoir is a multiple-purpose reservoir providing power generation, flood control and low flow augmentation. The normal minimum pool elevation is 960 MSL with storage of approximately 260,000 day-second-feet between elevations 960 and 900 MSL. Although not a primary purpose, stored water below minimum pool elevation 960 is available for low flow augmentation in periods of drought. Release below elevation 960 requires specific approval of the TVA Board of Directors. Power generation at

Norris can be maintained to about elevation 900 MSL. Of all the annual maximum elevations recorded, the lowest annual maximum elevation of Norris Reservoir was 993.8 MSL and occurred in June 1954.[7]

Releases from Fort Loudoun Reservoir, located on the Tennessee River 72.4 miles upstream from Watts Bar, can be used to control the Watts Bar pool elevation. Normal minimum pool elevation of Fort Loudoun Reservoir is 807 MSL.[7] Inflows into Watts Bar Reservoir from the Tennessee River are more than capable of maintaining the minimum pool elevation of Watts Bar Reservoir even under extreme conditions.

2.5.1.5 FLOOD HISTORY

Clinch River gaged stage or discharge records have been maintained at Wheat, downstream from the Site, during the years 1937-1963 and during the water year of 1967-68.[3,4,5,6] Stage records are available at Kingston, near the mouth of the Clinch River from 1874 except for the years 1877-82. Mixed stage and discharge records are available upstream at Clinton from 1883 except for the years 1949-64. Discharge records have also been maintained for various time periods at Scarboro, Lake City and Norris Dam, all upstream from the Site.

Judging from these gage records and from newspaper and other historical accounts, a March 1886 flood was one of the greatest known on the Clinch River. It reached about elevation 764 at the upper limit of the Site (CRM 18) and about elevation 758 at CRM 16.[2] Backwater up the Clinch River from the maximum known Tennessee River Flood of March 1867 approached the 1886 levels near CRM 16 but was substantially lower at CRM 18.[2]

A record breaking flood occurred in March 1929 on the Emory River which enters the Clinch River at CRM 4.4.[2] In the natural state this flood did not exceed the 1886 and 1867 flood levels upstream on the Clinch River at the Site. Under present-day conditions, a repetition of this 1929 flood would cause the maximum known regulated level, producing an elevation of 751 MSL upstream on the Clinch River beyond the Site. The maximum Clinch River flood of 1886 would be reduced to a lower level of about elevation of 748 MSL by Norris Reservoir. This figure would include backwater from Watts Bar Dam.

The largest flood since completion of the present TVA System occurred in March 1973 when elevations 749.6 and 748.3 were reached at CRM 17.8 and CRM 14.5, respectively, as can be seen in Table 2.5-6.[8] This flood resulted from unusually intense rainfall below Norris Dam and below other TVA tributary reservoirs. Intense rainfall produced high local and Emory River flows and record high Watts Bar Reservoir elevations.

Plant grade is established at elevation 815 which is well above the maximum flood runup level on record.

2.5.1.6 WATER TEMPERATURES

Water temperatures have been observed at Clinch River Mile 21.6 since May 1963. The maximum temperature observed during the period of record was 78 degrees F and occurred on June 23, 1965 and June 21, 1968. Minimum temperature observed was 33 degrees F and occurred on January 22, 1970.[8,10] Table 2.5-7 gives the average daily maximum, minimum and mean temperatures for each month.

The water temperatures of the Clinch River at the Site can be affected by unusual flow regulation circumstances. On week days, when water is discharged from Melton Hill Reservoir at high rates (16,000 to 23,000 cubic feet per second) during the summer months, all flow in the Clinch River below the dam is in a downstream direction. However, on weekends these discharges are generally reduced or cut off completely. As a result, the colder Clinch River water, at a reduced flow rate, can enter the mainstream of the Tennessee River along the stream bottom and the warmer Tennessee River waters flow upstream in the Clinch River at or near the surface all the way to Melton Hill Dam. Therefore, the water temperatures at the Site will be cool while normal releases are maintained at Melton Hill Dam but may be higher during low flow or no flow time periods.

2.5.1.7 RIVER VELOCITY

River velocity at the CRBRP Site is highly variable and depends upon turbine operations at Melton Hill, Fort Loudoun and Watts Bar Dams. Law Engineering Testing Company in conjunction with TVA has investigated transient flow conditions at the Clinch River Site and has defined some postulated conditions under which reverse flow and velocity could occur at the Site.[11] These postulated conditions are based on actual operations of the three dams.

Upstream flows at the Site could be caused by the abrupt shutdown of turbines at Melton Hill and Watts Bar and by the release of water from Fort Loudoun. Measurements of such upstream flows have not been made at the Site, but their existence is predicted by analyses of unsteady flow conditions within Watts Bar Reservoir under typical patterns of turbine operation.[11] The effects of the operation of each dam were determined first. On the basis of the effects created by the operation of each of the individual dams, the effects of a postulated turbine operation pattern, which superimposed in a critical way the effects of the individual operations, were studied. Results of these studies indicated that upstream velocities on the order of one foot per second can occur at the Site due to turbine operations. Figure 2.5-10 shows the velocity response at CRM 17 to postulated turbine operations patterned after actual operations of June 4 and 5, 1972. All unsteady flow computations were made by TVA utilizing an unsteady flow computer program developed at TVA by the Flood Control Branch. Comparison of computed and observed upstream velocities due to turbine operations at other sites where velocity observations were available indicates excellent agreement between computed and observed values.

2.5.1.8 SURFACE WATER QUALITY

A copy of the Federal Water Pollution Control Act and a copy of the Tennessee State water quality standards are included in the Appendix to this section. These standards apply to the waters affected by plant construction and operation. Data from several water-quality monitoring stations indicate the water quality of the Clinch River meets applicable standards.

Table 2.5-8 contains water quality data, including pH, temperature, dissolved oxygen, nitrogen, minerals, etc., observed during 1967-68 at CRM 79.8 and CRM 23.1, two sites upstream from the plant site.[12] ORNL water-quality monitoring data from the Oak Ridge Gaseous Diffusion Plant Pumping Station (CRM 14.4) and White Oak Dam (CRM 20.8) are in Tables 2.5-9 through 2.5-14.

Sources and locations of municipal and industrial waste discharges in the Clinch River Watershed[12] are listed in Tables 2.5-15 and 2.5-16, respectively, and are shown in Figure 2.5-11.

Water supply sources are discussed in Section 2.2 and listed in Tables 2.2-19 and 2.2-20. Programs for measuring and monitoring water quality in the vicinity of the plant site are discussed in Section 6.

2.5.1.9 PLANT REQUIREMENTS

The makeup water supply which is required to balance water lost through evaporation, drift, plant water usage and blowdown will be withdrawn from the Clinch River. For maximum power, the anticipated average water makeup requirement is 15.8 cfs. An average of 6.1 cfs will be returned to the water as blowdown and approximately 9.7 cfs will be consumed during plant operation. Consumptive use of 9.7 cfs is only 0.2 percent of the annual average Clinch River flowrate of 4,798 cfs, as can be seen in Table 3.3-1, Section 3.3, Plant Water Use. Actual water use may differ depending on plant power level and seasonal variability of evaporation.

2.5.2 GROUNDWATER

2.5.2.1 REGIONAL GROUNDWATER HYDROLOGY

The Site lies within the Valley and Ridge Physiographic Province of eastern Tennessee. The Valley and Ridge Province is a long narrow belt of faulted and folded predominantly calcareous Paleozoic rocks. It extends for 1,200 miles from the St. Lawrence Valley to the Gulf Coastal Plain in Alabama. In eastern Tennessee its average width is about 40 miles. This province lies between the Blue Ridge Province on the east and the Appalachian Plateau Province on the west and is characterized by a succession of northeast trending ridges of various widths. Ridges are capped by the less soluble cherty limestones, dolomites and shales and the valleys are developed in the more soluble limestones, dolomites and shales. Ancient thrusting and folding has resulted in nearly all of the beds dipping to the southeast. Groundwater hydrology of the Valley and Ridge Province in eastern Tennessee has been described in a bulletin from the Tennessee Department of Conservation.(13) More general discussions of the hydrology of carbonate rock terrains may be found in other articles on groundwater hydrology.(14,15,16,17)

The most important aquifers in the Valley and Ridge Province in eastern Tennessee are the carbonate rocks which underlie the majority of the province. Openings in which groundwater may be found in these carbonate rocks are of two types, primary openings which were formed at the time of the formation of the rock and secondary openings which have a later origin. Primary openings in the carbonate rocks in the Valley and Ridge province in eastern Tennessee are generally small and of little hydrologic importance. The size and distribution of the secondary openings largely control the hydrologic properties of the carbonate rocks. Secondary openings, which are largely fractures and openings along bedding planes and joints, permit the entrance of chemically reactive water which by weathering processes tends to increase the size of the openings through which it passes. Because the acidity of the water moving through a carbonate rock decreases as the calcium carbonate of the rocks is dissolved, the amount of weathering which takes place in these openings decreases with depth.

Groundwater recharge in the Valley and Ridge Province generally occurs over the entire area of the province. Recharge is most effective in those areas where the overburden soils are thin or permeable. Also, recharge may occur through sinkholes that penetrate relatively thick and impervious formations. During flood stages, water in surface streams may enter the aquifer locally; however, this local recharge does not represent a significant part of the recharge to the groundwater aquifer.

Natural discharge of the aquifer is through streams and springs. Movement of groundwater is from areas of recharge to areas of discharge.

Two geologic formations in the Valley and Ridge Province of particular interest in this report are the Chickamauga Group and the Knox Group. The Chickamauga Group which consists of limestone, shale and siltstone is found in many areas in eastern Tennessee and is subdivided into upper, middle and lower parts. The upper part of the Chickamauga consists of 700 to 1,000 feet of limestone and shale. The combined middle and lower parts of the Chickamauga range in thickness from about 2,000 to 6,000 feet and consist of limestones, shales and siltstones. Lower and middle parts of the Chickamauga Group are generally better aquifers than the upper part. Quality of water in the Chickamauga Group is varied and is influenced by local topography, local land use patterns, the depth below the surface at which the Chickamauga formation is encountered and small-scale geologic considerations.

Groundwater in the Chickamauga Group is largely restricted to fractures which have been enlarged by solutioning. The fracturing of the formation by folding has resulted in a system of cavities which are more or less interconnected. Many springs occur at the shale-limestone contacts and where solution-widened joints or fractures extend to the surface at topographic lows. In the lower and middle parts of the Chickamauga limestones small springs are common, several yielding more than 450 gallons per minute (gpm). Wells in these rocks usually have low yields when located on hills or other topographic highs and have larger yields when located near permanent streams. In the upper part of the Chickamauga limestones, some springs yield more than 100 gpm.

Siliceous dolomites, limestones and sandstones are included in the Knox Group. Water occurs in joints and solution channels and the yield of water to wells ranges from small to large. Numerous large springs are found in these rocks and the water is generally of good quality.

The Knox Group is the most important aquifer in eastern Tennessee. Occurrence of water in this formation is controlled by the extent of solution enlargement of fractures that are the result of ancient folding and faulting. Generally, the largest fractures are found in the first few hundred feet of depth and attempts to obtain larger yields from wells by drilling excessively deep wells have been unsuccessful.

2.5.2.2 SITE GROUNDWATER HYDROLOGY

The Valley and Ridge section of Roane County where the plant will be built is characterized by parallel ridges and valleys striking to the northeast. Higher portion of Chestnut Ridge, northwest of the plant site, has a broad well-rounded crest and is underlain by the cherty dolomites of the Knox Group. Valleys in Roane County are underlain by limestone or shale, each of which weathers more rapidly than do the dolomites.

Groundwater in Roane County, as elsewhere in east Tennessee, generally occurs in fractures in the underlying rocks. This water supplies drilled wells, dug wells and springs. Dug wells are most common in the thick residuum overlying the dolomite of the Knox Group, but some have been dug in shale and along valley bottoms in alluvial material. Dug wells often go dry during periods of drought.

The Knox Group and the lower and middle parts of the Chickamauga Group comprise an aquifer system in the vicinity of the plant site. The Clinch River, which bounds the groundwater system on three sides, is a groundwater sink; discharge from the aquifer system goes directly into the river or into streams which flow into the river. Because the incised meander of the river is a major topographic feature set down in bedrock,[18] it is unlikely that any groundwater flow could pass beneath the river.

A system of northeast tending ridges which cross the Site peninsula is assumed to represent locations of groundwater highs. The ridges provide boundaries to local aquifer systems existing between these groundwater highs. Initial confirmation of this assumption is provided by the groundwater highs associated with the two ridges nearest the Plant Island.

The higher portion of Chestnut Ridge appears to represent a boundary to the groundwater system of the entire peninsula, as can be seen in Figure 2.5-1. This ridge is a major topographic divide between Bear Creek Valley to the northwest and the peninsula formed by the Clinch

River southeast of the ridge. The summit of the ridge has an altitude greater than 1,100 feet above sea level and is more than 300 feet above the altitude of the plant site. Because of this difference in altitudes and because the upper portion of the ridge is nearly one mile from the plant site, it is unlikely that changes in groundwater levels at or near the plant site could affect groundwater levels northwest of Chestnut Ridge.

Permeabilities of the underlying rocks at the plant site were measured by means of packer permeability tests. Permeability is the rate of flow of water through a cross-section of unit area under a unit hydraulic gradient and may be expressed in terms of cubic feet per year per square foot, or equivalently, feet per year. The permeability and porosity, along with the water table gradient, determine the rate of water movement in the soil and in the weathered and fractured zones in the rock.

Values of permeability were measured at 22 borings at the plant site by means of 120 packer tests. Data obtained from the tests and the permeability values obtained from the data are shown in Table 2.5-17. Almost one-third of the permeability values are in the range of zero to 10 feet per year. More than 90 percent of the values are less than or equal to 800 feet per year. An inspection of Table 2.5-17 shows a clear trend for permeabilities to decrease with depth. The maximum measured values of permeability in the limestones and siltstones at the Site were not significantly different.

Due to the difficulty in maintaining open holes in the residual soils and more weathered portions of the underlying rocks, few packer tests were made in the more weathered zones. Thus, the permeabilities shown in Table 2.5-17 are representative of the less weathered materials on the Site and do not constitute a representative sample of permeabilities of the more weathered zones of the aquifer. Had it been possible to distribute the packer tests more uniformly among the zones of various degrees of weathering, it is likely that the median value of the permeability values would be larger than indicated in Table 2.5-17. Thus, the maximum permeabilities of the aquifer at the Site are probably greater than the maximum values shown in Table 2.5-17.

2.5.2.3 REGIONAL GROUNDWATER USE

A survey conducted by TVA to locate wells and springs that lie within a two-mile radius of the plant site was completed in June 1973. Results of the survey show that a total of 110 wells and springs are located to the south of the Clinch River which is a groundwater sink and none exist on the Site. The locations of these wells and springs are shown in Figure 2.5-12 and related data are presented in Table 2.5-18 which is a summary of the well survey data.

Nearly all of the wells inspected are small domestic wells of limited capacity. Only two wells within a two-mile radius of the Site can be classified as a municipal or public water supply well. Well number 13 supplies water to 16 mobile homes and well number 73 provides water for a commercial campground. No wells are used for industrial purposes. The majority are operated by small (less than 1.5 hp) electric pumps.

Seventeen public water supplies which obtain water from groundwater sources are located within a 20-mile radius of the Site. The nearest of these wells is at the Edgewood Elementary School located approximately 3.5 miles southwest of the Site. This well serves an estimated population of 196 persons and has an estimated average daily use of 4,900 gallons. Data on public groundwater supplies within a 20-mile radius of the Site are summarized in Table 2.5-19. The locations of these supplies are shown in Figure 2.5-13.

Seven industrial water supplies which obtain water from groundwater sources are located within a 20-mile radius of the plant site. The nearest of these industrial groundwater users is the Lenoir City Car Works which is located about 9.3 miles south of the plant site. Total daily groundwater withdrawal at this location is about 30,000 gallons. Data on industrial groundwater supplies within a 20-mile radius of the Site are summarized in Table 2.5-19. The locations of these supplies are also shown in Figure 2.5-13.

Present groundwater use in the region is limited primarily to agricultural and single family wells. Due to the abundance of surface water supplies and the relatively low yield of aquifers in the area, the character of future groundwater use is not expected to differ significantly from that of present use. The projected future groundwater uses in the region are not seen as having any significant effects upon groundwater conditions beneath the Site.

2.5.2.4 LOCAL WATER LEVELS

Groundwater occurs at the plant site primarily in weathered joints and fractures in the subsurface rocks. Movement of groundwater is largely restricted to the upper more weathered zones of the rock underlying the area.

Generally, groundwater at the Site occurs under water table conditions, but local and transient semi-confined conditions have been observed during periods of high water levels, especially in the low areas of the Site. Groundwater recharge is primarily derived from precipitation, although it is possible that in some restricted areas recharge may occur from the Clinch River during periods of rapid increase of river stage.

Thirty-four groundwater observation wells were installed by December 1, 1973, at the locations shown in Figure 2.5-14. Since December 1, 1973, other observation wells have been installed. In addition to the observation wells, eleven sealed piezometers are presently being installed in nests of two's and three's near borings 6, 7, 12, 40 and 27 to monitor piezometric surfaces at various depths in the aquifer profile. The purpose of these piezometers is to determine the occurrence of groundwater under water table conditions over the Site and to establish normal season-to-season and year-to-year variations of water levels.

Daily water level readings were made in 34 observation wells over the Site during the period from December 19, 1973, through January 4, 1974. Groundwater levels during this period of time were found to fluctuate over rather large ranges, primarily in response to large amounts of precipitation which occurred on the Site. Fluctuations were largest in observation wells located in topographic highs and smallest in wells located in topographic and groundwater lows. The data obtained during this period indicated that groundwater levels over the Site are related to depths of weathering (lower groundwater levels occurring in zones of greatest depth of weathering and consequently higher permeability) and only incidently related to surface topography.

Site groundwater contour maps, Figures 2.5-15 and 2.5-16, were developed from data recorded on December 24, 1973 and January 2, 1974, respectively. December 24, 1973, represents a time of rather low groundwater levels over the Site and January 2, 1974, represents a time of high groundwater levels. A feature of particular interest on both of these figures is the location of the groundwater low to the west of the Plant Island. This low occurs in the area of deepest weathering and lies about one-third of the way upslope from the topographic low toward the crest of the ridge to the northwest.

Response of the groundwater table to precipitation is rapid. Fluctuations in the elevation of the groundwater table amounting to several feet in one day during and after periods of large amounts of precipitation were noted. Such rapid response of the groundwater table to precipitation is indicative of rapid recharge, probably largely occurring in areas of exposed rock and small sinkholes along the ridges to the northwest and southwest which bound the Plant Island. Fluctuations in the groundwater table are in general largest in areas of topographic highs and smallest in areas of groundwater lows. The large fluctuations in and quick response to precipitation of the groundwater table in the topographic highs are likely due to smaller permeabilities in these areas and to the closer proximity of these areas to recharge areas. The smaller fluctuations in groundwater table in the area of the groundwater low are a result of a combination of higher permeability in this area and the regulating effect of the Clinch River which affords a relatively constant downstream boundary condition.

2.5.2.5 MOVEMENT OF GROUNDWATER

In general, movement of groundwater occurs in a direction normal to the groundwater contours. At the Site, movement is generally from topographically high areas to topographic lows; however, this pattern is modulated by the extent of weathering of the bedrock aquifers. Ultimately, the Clinch River acts as a sink to which all groundwater at the Site migrates. There are instances in carbonate rock terrains in which weathering in topographically high areas is so deep that interchanges between adjacent valleys separated by these topographic highs may occur.[13] Such situations are conducive to important reversals of groundwater flow. No evidence of such deep weathering action has been encountered at the Site. Sound rock was encountered in the core of the ridges at elevations higher than the adjacent valley floors. Thus, at the Site, the major ridges may be regarded as approximate locations of groundwater divides. Reversals in direction of flow which may occur because of the rather large fluctuations of the groundwater table will be local in extent and will not represent a diversion of groundwater from one major groundwater basin to another.

The Clinch River itself may act as a source of groundwater recharge during those periods when the river is subject to a rapid increase in stage. During such periods, groundwater will flow from the river into the aquifer. This reverse flow will occur until a new condition of dynamic equilibrium within the groundwater system is established.

2.5.2.6 EFFECTS OF PLANT CONSTRUCTION AND OPERATION ON GROUNDWATER SYSTEM

The groundwater environment at the Site will be substantially changed by the construction of the Plant Island. Presently, plans call for the foundation of the structures to be placed at elevation 720. Excavation for the Plant Island foundation will be preceded by dewatering. Due to the proximity of the Clinch River and the contiguous area of deeply weathered, more permeable rock between the Plant Island and the river and since the excavation will extend to a depth of at least 15 feet below the normal low stage of the river, considerable dewatering of the plant site to accommodate the proposed construction will be required.

The effect of the above described lowering of the water table will probably be to lower the water table around the Plant Island to an elevation below the normal water surface elevation in the Clinch River, and thus groundwater flow from the river toward the plant Site may be induced.

2.5.2.7 GROUNDWATER QUALITY

Seven groundwater samples for chemical analysis from observation wells located on the Site were obtained. The results of the chemical and physical tests of groundwater quality are given in Table 2.5-20. In general, the results of the chemical analyses of groundwater at the Site are comparable with those results from similar formations.[13] Total hardness conductivity, bicarbonate and iron content may be seen to be somewhat higher at the Site than is typical of the region and the water is more acidic at the Site. It is possible that the results of the analyses are influenced to some degree by the recent drilling operations. Groundwater at the Site is chemically suitable for human consumption, although the hardness of the water may be troublesome for some uses.

2.5.2.8 CONCLUSIONS

The potential for transmission of groundwater contaminants to present or future off-site groundwater users is small. For this reason the monitoring of groundwater for possible contamination may be restricted to periodic sampling and analysis of groundwater in the area of the Plant Island. Monitoring programs are discussed in Section 6.

TABLE 2.5-1

CLINCH RIVER STREAM GAGE LOCATIONS[3,4,5,6]

(1936 - 1968)

Station	River Mile	Period of Record	Drainage Area (sq. mile)
Near Wheat	14.4	1936 - 1941	3,385
	14.4	1967 - 1968	3,385
Below Melton Hill Dam	23.1	1962 - 1964	3,343
Near Scarboro	39.0	1941 - 1962	3,300

TABLE 2.5-2

PERIODS OF ZERO-RELEASE FROM MELTON HILL DAM[7]

May 1963 - October 1972

Consecutive days of zero-release	Number of Occurrences	Percentage of total number of occurrences
1	114	50.7
2	73	32.4
3	22	9.8
4	9	4.0
5	2	0.9
6	--	--
7	2	0.9
8	1	0.4
9	--	--
10	--	--
11	1	0.4
29	1	0.4
Total	225	

TABLE 2.5-3

AVERAGE MONTHLY TURBINE AND GATE DISCHARGES IN DAY-SECOND-FEET*[7]

MELTON HILL DAM

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1963					1,115	4,302	2,728	2,806	5,391	5,450	3,106	3,655	
1964	2,783	2,398	1,854	2,442	2,323	3,082	2,976	2,529	3,404	4,124	7,500	7,441	3,571
1965	10,126	5,123	3,568	5,891	3,997	2,505	2,390	5,099	5,626	3,524	4,269	3,181	4,608
1966	2,491	1,369	179	2,110	1,066	2,414	3,471	6,226	5,094	2,498	1,781	7,224	2,994
1967	7,098	4,505	10,184	3,399	1,011	4,683	5,011	6,132	7,121	7,296	3,920	10,608	5,914
1968	12,146	4,856	1,530	849	393	2,789	6,325	7,060	1,699	3,376	3,897	3,153	4,006
1969	2,850	4,930	2,444	1,607	2,276	3,002	4,506	3,310	2,557	1,734	3,296	3,434	2,996
1970	6,101	6,705	4,533	2,826	4,491	4,708	5,243	5,098	5,357	3,622	2,844	3,653	4,598
1971	3,522	5,855	2,490	2,508	5,719	6,342	3,332	5,564	5,483	6,073	7,580	7,187	5,138
1972	11,750	9,002	6,468	4,902	6,875	5,712	4,495	6,229	4,127	3,617	6,970	17,020	7,264
1973	8,463	4,914	9,898	4,090	8,905	9.278	4,929	7,451	5,456	3,838	5,147	10,288	6,888
Av.**	6,733	4,966	4,315	3,062	3,706	4,452	4,268	5,470	4,592	3,970	4,720	7,319	4,798

*Day-second-feet equals the average daily discharge in cubic feet per second (cfs).

**Averages are for the period 1964-1973.

TABLE 2.5-4

MELTON HILL DAM - 1973(7)

DISCHARGE IN DAY-SECOND-FEET*

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
DAY	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE	TURBINE	GATE
1	21,181	0	3,669	0	2,752	0	8,618	0	6,145	0	18,380	450	2,815	0	5,630	0	8,668	0	4,656	0	3,227	0	6,793	0
2	21,108	0	2,318	0	1,098	0	10,050	0	3,271	0	16,362	0	4,974	0	7,566	0	5,887	0	5,263	0	1,725	0	9,380	0
3	21,220	0	2,593	0	1,249	0	9,092	0	4,728	0	15,174	0	5,699	0	3,822	0	6,134	0	5,222	0	2,800	0	9,907	0
4	16,395	0	1,009	0	0	0	10,270	84	5,723	0	15,444	0	4,775	0	5,503	0	9,340	0	4,017	0	5,068	0	9,024	0
5	18,334	0	2,067	0	2,801	0	8,396	112	8,739	0	13,629	0	5,034	0	5,118	0	7,261	0	4,284	0	2,591	0	13,166	0
6	11,336	0	4,445	0	3,923	0	7,854	35	9,012	0	15,689	0	3,500	0	7,150	0	5,778	0	3,882	0	4,668	0	12,050	0
7	8,713	0	4,022	0	3,508	0	4,617	0	10,796	0	15,340	0	5,946	0	9,327	0	6,384	0	2,353	0	3,641	0	13,368	0
8	8,051	0	4,769	0	0	0	2,751	0	12,251	0	12,416	138	2,855	0	9,260	0	3,137	0	4,544	0	1,508	0	9,144	0
9	8,600	0	4,480	0	370	0	4,215	178	14,404	0	10,445	0	10,597	0	7,380	0	3,418	0	7,016	0	3,976	0	7,914	0
10	9,681	0	7,597	0	707	0	5,203	133	10,904	0	9,535	0	6,558	0	8,989	0	6,618	0	5,751	0	3,515	0	10,345	0
11	9,649	0	5,349	0	1,978	0	7,231	0	9,366	0	10,854	0	4,128	0	6,306	0	5,873	0	1,482	0	6,908	0	10,787	0
12	8,929	0	6,569	0	1,948	0	3,465	152	10,340	0	11,423	0	2,818	0	672	0	5,935	0	6,189	0	1,423	0	8,146	0
13	7,235	0	10,579	0	0	0	2,323	0	9,901	0	7,581	0	3,846	0	6,766	0	6,136	0	5,688	0	4,125	0	7,438	0
14	7,162	0	7,746	0	918	0	1,368	0	10,130	0	7,367	0	4,495	0	8,219	0	5,405	0	1,963	0	3,058	0	10,460	0
15	6,621	0	9,740	0	3,468	0	0	0	8,233	0	7,315	0	2,073	0	6,971	0	2,070	0	3,801	0	2,409	0	10,337	0
16	7,223	0	11,788	0	21,955	4,929	2,320	180	8,050	0	6,797	0	5,237	0	8,706	0	5,398	0	4,846	0	3,490	0	8,417	0
17	6,320	0	5,588	0	19,000	5,025	2,744	0	9,303	0	10,845	0	7,120	0	7,999	0	8,647	0	5,319	0	4,455	0	11,805	0
18	6,575	0	1,562	0	9,455	0	2,776	0	9,053	0	10,652	0	6,641	0	10,085	0	2,459	0	3,691	0	604	0	9,420	0
19	2,391	0	4,774	0	3,901	0	2,698	83	9,916	0	7,385	0	6,263	0	5,523	0	3,639	0	2,750	0	1,262	0	9,516	0
20	2,772	0	5,083	0	9,814	0	965	0	5,302	0	1,893	0	6,395	0	6,861	0	4,557	0	1,510	0	2,996	0	9,107	0
21	1,173	0	4,407	0	17,403	0	0	0	7,551	0	4,891	0	6,828	0	9,499	0	7,304	0	0	0	3,168	0	12,196	0
22	3,332	0	7,363	0	18,450	0	0	0	5,945	0	6,079	0	1,542	0	9,804	0	4,252	0	2,275	0	3,004	0	10,072	0
23	5,870	0	2,319	0	20,900	0	2,384	0	5,097	0	5,121	0	6,763	0	9,355	0	0	0	3,596	0	1,041	0	9,510	0
24	9,891	0	1,198	0	22,291	0	1,269	0	1,813	0	4,917	0	5,693	0	9,038	0	6,174	0	3,095	0	865	0	9,818	0
25	6,860	0	949	0	21,354	0	0	0	3,195	0	5,272	0	7,329	0	7,672	0	4,860	0	3,714	0	4,183	0	9,951	0
26	6,526	0	4,003	0	19,407	0	1,412	0	1,326	0	5,822	0	4,815	0	8,427	0	4,500	0	3,217	0	3,713	0	22,299	0
27	4,625	0	5,873	0	19,042	0	6,840	0	7,922	0	4,844	0	1,326	0	6,294	0	5,112	0	1,554	0	18,627	0	12,929	0
28	4,133	0	5,730	0	19,490	0	5,902	0	15,852	0	7,241	0	1,667	0	7,689	0	5,568	0	0	0	20,748	4,549	6,065	0
29	6,255	0			19,030	0	2,939	0	16,334	0	4,795	0	2,725	0	9,117	0	5,498	0	6,919	0	18,942	0	2,147	0
30	2,975	0			17,230	22	4,031	0	14,474	0	4,235	0	5,866	0	9,013	0	7,667	0	5,775	0	12,109	0	11,485	0
31	1,211	0			13,430	0			20,980	0			6,686	0	7,713	0			4,605	0			15,936	0
TOTAL	262,347	0	137,589	0	296,872	9,976	121,733	957	276,056	0	277,743	588	152,809	0	230,974	0	163,679	0	118,977	0	149,849	4,549	318,932	0
AVERAGE	8,463	0	4,914	0	9,577	322	4,058	32	8,905	0	9,258	20	4,929	0	7,451	0	5,456	0	3,838	0	4,995	152	10,288	0

1972-1973	WATER YEAR DISCHARGE	
	TOTAL	AVERAGE
TURBINE	2,768,649	7,585
GATE	11,521	32
COMBINED	2,780,170	7,617

MAXIMUM DAILY AVERAGE DISCHARGE 26,884 ON MARCH 16.

MAXIMUM DAILY AVERAGE DISCHARGE SINCE FINAL CLOSURE (MAY 1, 1963) 26,884 ON MARCH 16, 1973.

DISCHARGE DOES NOT INCLUDE LOCKAGE.

1973	ANNUAL DISCHARGE	
	TOTAL	AVERAGE
TURBINE	2,507,560	6,870
GATE	16,070	44
COMBINED	2,523,630	6,914

*Day-second-feet equals the average daily discharge in cubic feet per second (cfs).

TABLE 2.5-5

WATTS BAR RESERVOIR ELEVATIONS(7)

1964 - 1973

Month	Maximum*	Minimum*	Average*
January	742.42	734.70	735.77
February	738.56	734.80	735.73
March	745.40	734.80	736.14
April	744.57	735.06	739.41
May	745.06	740.10	741.20
June	742.55	739.45	740.98
July	743.82	739.36	740.74
August	742.23	739.38	740.71
September	742.14	739.47	740.90
October	742.08	738.07	739.65
November	742.70	734.92	737.39
December	743.42	734.74	735.93

* Units in feet above mean sea level (MSL)

TABLE 2.5-6

MARCH 17, 1973, HIGH-WATER MARKS
CLINCH RIVER IN VICINITY OF CRBRP SITE

No.	River Mile	Elevation (feet)
1	17.83	749.6
2	17.17	749.2
3	16.50	748.8
4	16.18	748.6
5	15.30	748.4
6	14.56	748.3

TABLE 2.5-7

AVERAGE DAILY MAXIMUM, MINIMUM AND MEAN TEMPERATURES FOR EACH MONTH*
(1963 - 1971)

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Maximum	44	44	49	57	63	65	66	67	68	66	58	49
Minimum	41	41	45	54	60	62	63	65	66	63	56	47
Average	43	42	47	55	61	64	64	66	67	64	57	48

*Clinch River Mile 21.6

TABLE 2.5-8

CLINCH RIVER WATER QUALITY DATA[12]

CLINCH RIVER MILE 79.8

Date	Time ET 24-hr Clock	Location in Stream*	Depth (ft)	Stream Disch. (cfs)	Coliforms Fecal (MPN/100 ml)	Coliforms Total (MPN/100 ml)	Water Temp. (°F)	DO (mg/l)	5-Day 20°C BOD (mg/l)	Color (PCU)	Turb (JCU)	Nitrogen** Crg. (mg/l)	Nitrogen** NH_3 (mg/l)	Nitrogen** NO_2 (mg/l)	Nitrogen** NO_3 (mg/l)	Phosphate Sol. (mg/l)	Phosphate Total (mg/l)	pH	Alkalinity ($CaCo_3$) Phen. (mg/l)	Alkalinity ($CaCo_3$) Total (mg/l)	Total Hardness ($CaCo_3$) (mg/l)
6/22/67	1055	Tailrace ∇	0.5	6,400	2	62	50.2	7.8	0.5	5	<5	0.37	0.00	0.01	0.43	0.01	0.01	7.8	0	89	115
7/27/67	0905	Tailrace	0.5	6,670	130	220	51.8	5.1	0.7	10	28	0.11	0.00	0.01	0.60	0.03	0.03	7.8	0	88	119
8/15/67	1050	Tailrace	0.5	8,500	6	130	57.2	2.9	1.2	15	6	0.08	0.13	0.01	0.48	0.01	0.01	7.6	0	10	129
9/26/67	1120	Tailrace	0.5	8,220	2	6	62.6	0.9	0.2	50	36	0.50	1.18	0.02	0.42	0.07	0.12	7.5	0	105	116
10/18/67	1820	Tailrace	0.5	7,220	11	11,000	64.4	2.3	0.3	30	43	0.27	0.09	0.01	0.23	0.06	0.11	7.7	0	105	128
11/8/67	1515	Tailrace	0.5	2,220	6	23	60.8	6.7	0.3	10	15	0.14	0.18	<0.01	0.19	0.05	0.09	7.6	0	85	101
2/15/68	0920	Tailrace	1.0	6,390	3	23	33.8	11.2	1.2	10	15	0.25	0.06	0.02	0.54	0.04	0.18	8.2	0	103	--
4/24/68	1700	Tailrace	1.0	0	160	620	42.8	10.5	<1.0	10	2	0.04	0.05	<0.01	0.80	0.05	0.05	7.8	0	92	96
									CLINCH RIVER MILE 23.1												
6/23/67	1415	Tailrace ∇∇	0.5	16,500	94	940	64.6	8.6	0.0	5	14	0.40	0.01	0.02	0.40	0.01	0.11	7.8	0	96	128
7/28/67	1340	Tailrace	0.5	8,600	110	360	66.6	7.7	1.1	10	23	0.07	0.15	0.01	0.52	0.01	0.07	7.9	0	90	112
8/15/67	1535	Tailrace	0.5	15,260	3	230	63.5	7.9	0.9	15	31	0.09	0.09	0.01	0.47	0.05	0.25	7.5	0	92	124
9/26/67	1650	Tailrace	0.5	8,340	36	110	66.7	5.9	0.7	5	2	0.24	0.00	0.02	0.43	0.07	0.14	7.6	0	106	112
10/19/67	1305	Tailrace	0.5	8,340	16	3,400	62.6	6.2	1.6	10	8	0.34	0.17	0.03	0.31	0.06	0.16	7.9	0	100	125
11/8/67	1155	Tailrace	0.5	9,000	62	160	59.0	8.1	0.3	10	9	0.13	0.12	0.01	0.23	0.01	0.13	7.8	0	97	115
2/16/68	0900	Tailrace	1.0	7,500	3	36	41.0	11.7	<1.0	5	10	0.25	0.11	0.02	0.57	0.06	0.12	7.2	0	111	--
4/25/68	1815	Tailrace	1.0	0	<2	50	60.4	9.6	1.3	15	3	0.63	0.03	0.01	0.47	0.05	0.09	8.0	0	92	100

*Location in Stream: Percent distance from left bank looking downstream

**Nitrogen: Values shown are mg/l nitrogen in the forms listed

∇ Tailrace: Norris Dam

∇∇ Tailrace: Melton Hill Dam

(Continued)

TABLE 2.5-8 (Continued)

CLINCH RIVER MILE 79.8

Date	Time ET 24-hr Clock	Location in Stream*	Depth (ft)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	Na (mg/l)	K (mg/l)	Iron Fe^{++} (mg/l)	Iron Total (mg/l)	Mn, Total (mg/l)	SO_4 (mg/l)	SiO_2 (mg/l)	Specific Conductance at 25°C (µmhos/cm)	Solids Sus. (mg/l)	Solids Dis. (mg/l)	Solids Total (mg/l)
6/22/67	1055	Tailrace▽	0.5	27.8	11.0	11	3.00	1.30	0.10	0.10	0.06	10	4.8	240	0	112	112
7/27/67	0905	Tailrace	0.5	28.8	11.4	3	2.50	1.40	0.01	0.12	0.06	12	3.9	241	13	131	144
8/15/67	1050	Tailrace	0.5	32.8	11.4	3	4.20	1.40	0.01	0.07	0.04	8	3.8	235	26	102	128
9/26/67	1120	Tailrace	0.5	31.0	9.4	7	2.50	1.30	0.01	0.10	0.21	18	3.4	284	4	130	134
10/18/67	1820	Tailrace	0.5	35.0	9.3	2	2.20	1.40	0.02	0.80	0.43	16	4.2	249	1	143	144
11/8/67	1515	Tailrace	0.5	26.0	8.8	3	2.40	1.50	0.02	0.73	0.09	14	--	222	0	129	129
2/15/68	0920	Tailrace	1.0	--	--	2	2.70	1.20	<0.05	--	--	12	3.0	210	10	130	140
4/24/68	1700	Tailrace	1.0	23.0	9.5	3	1.70	3.80	<0.05	0.06	0.02	10	2.7	240	--	--	--

CLINCH RIVER MILE 23.1

Date	Time ET 24-hr Clock	Location in Stream*	Depth (ft)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	Na (mg/l)	K (mg/l)	Iron Fe^{++} (mg/l)	Iron Total (mg/l)	Mn, Total (mg/l)	SO_4 (mg/l)	SiO_2 (mg/l)	Specific Conductance at 25°C (µmhos/cm)	Solids Sus. (mg/l)	Solids Dis. (mg/l)	Solids Total (mg/l)
6/23/67	1415	Tailrace▽▽	0.5	27.7	14.4	2	2.00	3.00	--	0.47	0.20	12	4.3	253	27	121	148
7/28/67	1340	Tailrace	0.5	28.8	9.6	5	2.30	1.50	0.01	0.40	0.07	16	4.6	201	2	120	122
8/15/67	1535	Tailrace	0.5	31.8	10.8	9	2.20	1.40	0.00	0.26	0.04	14	3.7	230	20	122	142
9/26/67	1650	Tailrace	0.5	29.5	9.2	18	1.70	1.40	0.01	0.21	0.07	18	3.5	284	63	90	153
10/19/67	1305	Tailrace	0.5	34.0	9.3	2	2.60	1.50	0.01	0.22	0.04	13	3.6	284	8	132	140
11/8/67	1155	Tailrace	0.5	31.0	9.1	3	2.80	1.60	0.02	0.17	0.45	14	--	266	15	98	113
2/16/68	0900	Tailrace	1.0	--	--	3	2.30	1.00	<0.05	--	--	14	4.0	240	--	140	140
4/25/68	1815	Tailrace	1.0	26.0	9.0	3	3.00	4.00	<0.05	0.19	0.04	12	1.1	230	10	100	110

*Location in Stream: Percent distance from left bank looking downstream.
**Nitrogen: Values shown are mg/l nitrogen in the forms listed.
▽Tailrace: Norris Dam.
▽▽Tailrace: Melton Hill Dam.

TABLE 2.5-9

NON-RADIOACTIVE WATER MONITORING DATA - WHITE OAK DAM[19]

1971

Substance	Number of Samples	Concentration (mg/l) Maximum	Minimum	Average	STD	Percent STD
Cr	3	1.000	0.100	0.400	0.05*	800
Phenols	4	0.0008	0.0001	0.0005	0.001*	50
$SO_4^{=}$	4	39.0	28.5	34.4	250*	14
NO_3^-	4	8.7	0.9	5.3	45*	12
Cl^-	4	6.5	3.1	4.8	250*	2
Hg	32	0.0070	< 0.0005	< 0.0020	0.005	< 40
Pb	3	0.02	< 0.005	< 0.012	0.05*	< 24

*U. S. Public Health Service Drinking Water Standards

TABLE 2.5-10

NON-RADIOACTIVE WATER MONITORING DATA - WHITE OAK DAM[19]

1972

Substance	Number of Samples	Concentration (mg/l) Maximum	Minimum	Average	STD	Percent STD
Cr	4	0.20	0.05	0.1 ± 0.01	0.05*	228
Phenols	4	0.006	< 0.0001	< 0.0002 ± 0.00002	0.001*	< 20
$SO_4^=$	19	72.5	13.5	51.5 ± 9.4	250*	21
NO_3^-	10	6.5	3.1	5.1 ± 0.3	45*	11
Cl^-	3	3.4	1.7	2.2 ± 0.1	250*	1

*U.S. Public Health Service Drinking Water Standards

NOTE: Stream not a source of drinking water. Drinking water standards used for water quality comparison only.

TABLE 2.5-11

SUMMARY OF DISCHARGE-WEIGHTED MEAN VALUES* OF STABLE CHEMICAL ANALYSES** OF CLINCH RIVER WATER[20]

WHITE OAK DAM

	WOD +
Bicarbonate	125.000
Calcium	32.000
Magnesium	6.000
Chloride	5.100
Sulfate	23.000
Nitrate	8.200
Iron	0.080
Phosphate	0.600
Potassium	1.600
Sodium	1.400
Silicon	1.700
Specific Conductance	283.000
Strontium	0.065
Discharge++	14.000

*Concentrations in mg/liter, except pH in pH units, specific conductance in micromhos/cm, and discharge in cfs

**Chemical analyses performed on filtered samples

+Sample period, November 18, 1961 to November 30, 1963 at White Oak Dam

++Time-weighted mean for the total sampling period

TABLE 2.5-12

NON-RADIOACTIVE WATER MONITORING DATA - ORGDP PUMPING STATION[19]

1971

Substance	Number of Samples	Concentration (mg/l) Maximum	Minimum	Average	STD	Percent STD
Cr	11	0.008	0.005	0.005	0.05*	10
Phenols	3	0.0004	0.0001	0.0002	0.001*	20
$SO_4^=$	4	25.2	21.0	22.7	250*	9
NO_3^-	4	7.5	0.7	4.7	45*	10
Cl^-	4	5.5	1.6	3.1	250*	1
Hg	32	0.0070	<0.0005	<0.0018	0.005	<36
Pb	3	0.02	<0.005	<0.012	0.05*	<24

*U. S. Public Health Service Drinking Water Standards

TABLE 2.5-13

NON-RADIOACTIVE WATER MONITORING DATA - ORGDP PUMPING STATION[19]

1972

Substance	Number of Samples	Concentration (mg/l)				Percent STD
		Maximum	Minimum	Average	STD	
Cr	4	0.01	<0.005	<0.005 ±0.0005	0.05*	<10
Phenols	3	<0.0001	<0.0001	<0.0001**	0.001*	<10
$SO_4^{=}$	19	17.0	8.5	13.0 ±2.4	250*	5.2
NO_3^{-}	10	4.4	1.9	2.9 ±0.2	45*	6.4
Cl^{-}	3	2.4	<1.0	<1.2 ±0.07	250*	<0.5

*U. S. Public Health Service Drinking Water Standards

**All values below limit of detection

TABLE 2.5-14

SUMMARY OF DISCHARGE-WEIGHTED MEAN VALUES* OF STABLE CHEMICAL ANALYSES** OF CLINCH RIVER WATER[20]

ORGDP PUMPING STATION

	CRM 14.4+
pH	7.700
Bicarbonate	119.000
Calcium	21.000
Magnesium	7.700
Chloride	1.600
Sulfate	10.000
Nitrate	2.700
Iron	0.060
Phosphate	0.220
Potassium	1.300
Sodium	2.400
Silicon	1.500
Specific Conductance	216.000
Suspended Solid	25.300
Dissolved Solid	129.000
Total Solids	154.000
Strontium	0.070
Discharge++	4620.000

*Concentrations in mg/liter, except pH in pH units, specific conductance in micromhos/cm, and discharge in cfs

**Chemical analyses performed on filtered samples

+Sample period, November 28, 1960 to January 8, 1962

++Time-weighted mean for the total sampling period

TABLE 2.5-15

CLINCH RIVER WATERSHED
MUNICIPAL WASTE DISCHARGES[12]
(Identifying numbers correspond to Figure 2.5-3)

Number*	County	Name	Sewered Population	Type Treatment	Treated Waste Population Equivalent	Receiving Stream	Outfall Location River Mile
1	Anderson	Clinton - Plant No. 1	4,570	Secondary	876	Clinch River	56.8
1a	Anderson	Clinton - Plant No. 2		Secondary		Clinch River	64.1
1b	Anderson	Clinton - Plant No. 3		Secondary		Clinch River	61.4
2	Anderson	Lake City	2,120	Secondary	200	Coal Creek	3.1
3	Anderson	Norris	1,150	Secondary	50	Buffalo Creek	4.1
4	Anderson	Oak Ridge, East	8,510	Secondary	300	Unnamed tributary to Clinch River	0.6
4a	Anderson	Oak Ridge, West	17,070	Primary	11,700	East Fork, Poplar Creek	8.2
	Knox	Hallsdale-Powell U.D.					
5	Knox	Plant No. 1	5,490	Secondary	500	Beaver Creek	31.8
5a	Knox	Plant No. 2	1,810	Secondary	200	Beaver Creek	26.4
5b	Knox	Plant No. 3	2,080	Secondary	20	Beaver Creek	23.4
6	Loudon	Lenoir City	4,400	Secondary	500	Unnamed tributary to Tennessee River	0.4
7	Loudon	Loudon	3,790	Secondary	365	Tennessee River	591.0
8	Roane	Harriman	7,460	Primary	83,400++	Tennessee River	567.6
9	Roane	Kingston - Plant No. 1	3,240	Primary	625	Clinch River	0.8
9a	Roane	Kingston - Plant No. 2	1,640	Primary	250	Martin Branch∇	0.8
10	Roane	Oliver Springs	1,590	Secondary	60	Poplar Creek	14.4
11	Roane	Rockwood	5,120	Secondary**	500	Black Creek	5.2
12	Rhea	Dayton	4,450	Secondary**	1,880	Richland Creek	2.4
13	Rhea	Spring City	1,750	Primary+	360	Piney River, Emb.	4.0
14	Rhea	Watts Bar Resort	365	Secondary	40	Tennessee River	530.1
15	Bradley	Cleveland	21,930	Secondary	6,900	South Mouse Creek	10.4

*Identifying numbers correspond to Figure 2.5-11

**Wastewater from Mead is discharged along with the effluent from the municipal treatment plant

+This effluent passes through an abandoned quarry before entering Martin Branch

++Addition to treatment plant is under construction

∇Plans in progress for new secondary treatment plant

TABLE 2.5-16

CLINCH RIVER WATERSHED
INDUSTRIAL WASTE DISCHARGES*(12)
(Identifying numbers correspond to Figure 2.5-11)

Number	County	City	Name of Industry	Principal Product	Type Treatment	Treated Waste Characteristics			Receiving Stream	Outfall Location River Mile	Comments
I-1	Anderson	Clinton	Armstrong Rubber Tire Co.	Small rubber tires		BOD_5	1.0	mg/l	Clinch River	62.8	Planning stage
						COD	20.0	mg/l			
						Sus. Solids		mg/l			
						Set. Solids		ml/l			
						Phenols	0.001	mg/l			
						Oil	0.50	mg/l			
I-2	Anderson	Clinton	FMC - Link Belt Division	Forging and machining roller bearings		Solids		mg/l	Clinch River	65.1	Planning stage
						Oil		mg/l			
I-3	Anderson	Clinton	Modine Mfg. Co.	Refrigeration condensers and evaporators	Neutralization and Sedimentation	Solids		mg/l	Clinch River	64.3	
						Al		mg/l			
						Zn		mg/l			
						F		mg/l			
						pH					
						Cl^-		mg/l			
I-4	Anderson	Clinton	Sprague Electric Co.	Aluminum foil for electrical components	Chemical - physical batch and continuous deionazation for chromium	Al		mg/l	Clinch River	64.3	Under construction
						Cu		mg/l			
						Fe		mg/l			
						Ni		mg/l			
						Zn		mg/l			
						B		μg/l			
						Cl^-		mg/l			
						NO_3		mg/l			
						PO_4		mg/l			
						Temperature		°C			
I-5	Anderson	Clinton	U.S.-T.V.A.-Bull Run Steam Plant	Electric power	None	Sus. Solids		mg/l	Clinch River	46.8	
						Set. Solids		ml/l			
						Temperature		°C			
					Sedimentation	Sus. Solids	19.0	mg/l	Clinch River	46.7	
						Set. Solids		ml/l			
						pH	8.8				
					Secondary	BOD_5	17.0	mg/l	Clinch River	47.0	

(Continued)

TABLE 2.5-16 (Continued)

Number	County	City	Name of Industry	Principal Product	Type Treatment	Treated Waste Characteristics	Receiving Stream	Outfall Location River Mile	Comments
I-6	Anderson	Oak Ridge	American Nuclear Corp.	No longer operational	Evaporation Sedimentation	Low level radioactivity leaching from the site	Braden Br.	1.0	Plant closed
I-7	Anderson	Oak Ridge	Ralph Rogers & Co.	Broken limestone, sand and gravel	Evaporation Sedimentation	Sus. Solids Set. Solids pH			
I-8	Anderson	Oak Ridge	Tennright Plating Ind. Inc.	Metal plating					
I-9	Anderson	Oak Ridge	U.S. Atomic Energy Commission Gaseous Diffusion Plant	Enriched Uranium 235	Lagoon		Clinch River	11.4	
					Ponds in Series		Poplar Creek	1.2	
					Primary		Poplar Creek	1.3	
					Limestone Neutralization Pit		Poplar Creek	2.5	
					Limestome Neutralization Pit		Poplar Creek	2.7	
					Equalization and Dillution		Poplar Creek	4.5	
					Primary		Clinch River	12.8	Power house san. waste may not be operating
	Anderson	Oak Ridge	National Laboratory	Reactor development Radioisotope Dev.	Primary		White Oak Creek	2.3	
					Secondary		Melton Br.	1.1	
					Sedimentation	Radionuclides	White Oak Creek	2.6	
					None	Laundry waste	White Oak Creek	2.4	
	Anderson	Oak Ridge	Y-12 Area	Atomic weapons and components, fabrication support for weapons design agencies	Oil recovery and flow equalization		E. Fk. Poplar Creek	14.7	
					Seepage ponds		Bear Creek	Head-waters	

(Continued)

TABLE 2.5-16 (Continued)

Number	County	City	Name of Industry	Principal Product	Type Treatment	Treated Waste Characteristics	Receiving Stream	Outfall Location River Mile	Comments
I-9	Anderson	Oak Ridge	Agricultural Research Laboratory	Radiological research, applied radio-botany, plant breeding	Secondary		Scaraboro Creek	8.3	Livestock waste may be treated by oxidation ponds and spray irrigation
I-10	Knox	Halls Crossroads	Avondale Farms Creamery Inc.	Pasteurized milk, milk products	Spray irrigation None (cooling)	-- Temperature	None Drainage Ditch to Beaver Creek	 36.7	
I-11	Knox	Powell	Broadacres Dairy Inc.	Pasteurized milk, milk products	Spray irrigation None (cooling)	-- Temperature	None Dry stream to Beaver Creek	 25.3	
I-12	Knox	Concord	Herron Packing Co.	Custom slaughtering	Primary solids removal anerobic oxidation, aerobic oxidation	BOD_5 COD Sus. Solids Set. Solids	Dry stream To Conner Creek	2.1	
I-13	Loudon	Lenoir City	Eaton, Corp.	Locks, door and window hardware	Chemical-physical	Oil Cu CN Cr Fe Ni Pb Temperature pH N	Tennessee River	600.2	

(Continued)

TABLE 2.5-16 (Continued)

Number	County	City	Name of Industry	Principal Product	Type Treatment	Treated Waste Characteristics	Receiving Stream	Outfall Location River Mile	Comments
I-14	Loudon	Lenoir City	Southern Railway System Lenoir Car Works	Bearings for Rail cars	None	Dis. Solids Oil Cu Fe Pb	Blue Springs Creek	0.5	
I-15	Loudon	Lenoir City	Wamplers' Wholesale Meats	Slaughter house and meat processing	(State recommendations pending)	BOD_5 Dis. Solids Sus. Solids Set. Solids Oil Grease N P	Hines Creek	6.8	
I-16	Loudon	Loudon	Union Carbide, Food Products Div.	Cellophane packaging for food products	Secondary	BOD_5 COD Color Sus. Solids Set. Solids pH SO_2 N P	Tennessee River	591.7	
I-17	Monroe	Sweetwater	The Langsdale Co. Cherokee Div.	Pressure creosoted timber products	Sedimentation and skimmer	BOD_5 COD Phenols Temperature	Sweetwater Creek	22.0	
I-18	Roane	Harriman	The Mead Corp.	Corrugated paperboard	Screening	Color Sus. Solids Set. Solids Dis. Solids Temperature NH_3 360 mg/l	Tennessee River	567.6	
					Primary	BOD_5 94 mg/l	Emory River		

(Continued)

TABLE 2.5-16 (Continued)

Number	County	City	Name of Industry	Principal Product	Type Treatment	Treated Waste Characteristics	Receiving Stream	Outfall Location River Mile	Comments
I-19	Roane	Harriman	Roane Hosiery Inc.	Ladies hosiery	None (cooling)	Trace Oils Temperature	Bullard Br.	0.4	
I-20	Roane	Kingston	U.S.-TVA-Kingston Steam Plant	Electric power	None	Sus. Solids Set. Solids Temperature	Clinch River	2.6	
					Sedimentation	Sus. Solids 29.0 mg/l Set. Solids pH 5.2-7.6	Emory River		
I-21	Roane	Rockwood	Palm Beach Co.	Coats and pants	Secondary	BOD_5	Post Oak Creek	0.3	
I-22	Roane	Rockwood	Roane Electric Furnace Corp.	Manganese alloy	None (cooling)	Sus. Solids Set. Solids Oil Temperature Fe Mn	Cardiff Cr.	3.3	
					None (runoff)	Sus. Solids Set. Solids Oil Cr Fe Mn	Cardiff Cr.	3.3	
I-23	Roane	Rockwood	Tennessee Forging Steel	Iron and steel continuous casting	None (cooling)	Sus. Solids Set. Solids Oil Grease Temperature Fc Mn	Cardiff Cr.		

(Continued)

TABLE 2.5-16 (Continued)

Number	County	City	Name of Industry	Principal Product	Type Treatment	Treated Waste Characteristics	Receiving Stream	Outfall Location River Mile	Comments
I-24	Rhea	Dayton	Chevron Chemical Co.	Polymer fibers	Evaporation None (cooling)	No discharge Temperature	Unnamed tributary to little Richland Cr.	0.5	
I-25	Rhea	Spring City	Southern Silk Mills	Textiles	None	BOD_5 400 mg/l Color pH NH_3	Town Creek	0.4	
	Rhea	Watts Bar Dam	Watts Bar Dam	Hydroelectric power	None (filter backwash)	Sus. Solids Set. Solids	Tennessee River		
I-26	Rhea	Watts Bar Dam	Watts Bar Nuclear Plant	Construction	Tertiary	BOD_5	Yellow Creek		
	Rhea	Watts Bar Dam	Watts Bar Steam Plant (utility building)	Electric power	Secondary	BOD_5 NH_3-N	Tennessee River		
I-27	Bradley	Charleston	Olin Corporation	Caustic soda, chlorine and high test hypochlorite	Recovery, lagoons, controlled release	Dis. Solids 20,000 mg/l Cl 10,000 mg/l Hg 30 μg/l Cl_2 1 mg/l	Hiwassee River	15.9	
					None (cooling)	Temperature Hg 15 μg/l			
I-28	Bradley	Cleveland	Magic Chef Inc.	Enameled kitchen appliances		Total Solids 4,840 mg/l Sus. Solids 650 mg/l Acidity 3,100 mg/l Cr 0.186 mg/l CN <0.10 mg/l Fe 570 mg/l Ni 10.1 mg/l	Big Spring Creek	1.6	

(Continued)

TABLE 2.5-16 (Continued)

Number	County	City	Name of Industry	Principal Product	Type Treatment	Treated Waste Characteristics	Receiving Stream	Outfall Location River Mile	Comments
I-29	McMinn	Calhoun	Bowaters Southern Paper Co.	Newsprint and sulphate pulp	Sedimentation, controlled release	BOD_5 201 mg/l Total Solids 1,260 mg/l Sus. Solids 56.5 mg/l pH 6.8	Hiwassee River	16.5	

*Identifying numbers correspond to Figure 2.5-11
Blank spaces indicate data is unavailable
DATA SOURCE:

"Comprehensive Plan for Water Quality Management" TVA, January 1969, Volume II

List of Municipal Wastewater Systems in Tennessee with Data Concerning Treatment and Disposal, January 1973

1970 Census of Population

Tennessee Public Hearings: Clinton January 19, 1971; Knoxville January 25, 1972 Spring City March 8, 1971; Athens June 11, 1970; Cleveland March 23, 1972

Tennessee Department of Public Health: Division of Water Quality Control and Visision of Sanitary Engineering, Knoxville and Chattanooga Offices

TABLE 2.5-17

SUMMARY OF PACKER TEST DATA

Permeability Tests at CRBRP Site

Boring	Date	Test Section[1]	L[2] (feet)	C_p[3]	G.W. Depth	Q[4] (gpm)	H_p[5] (feet)	Hg[6] (feet)	H[7] (feet)	K[8] (ft/yr)	Geologic Horizon[9]
B-26	10/2/73	24-298	274	320	--	8.9	23.1	45.0	68.6	42	U.A.S.S.
	9/28/73	30-298	268	325	--	10.1	23.1	41.6	64.7	51	U.A.S.S.
	9/28/73	50-298	248	350	--	8.4	23.1	41.6	64.7	45	U.A.S.S.
	9/29/73	70-298	228	380	--	8.6	57.8	41.6	99.4	33	U.A.S.S.
	--	90-298	208	420	--	4.9	23.1	38.6	61.7	33	U.A.S.S.
	10/2/73	110-298	188	450	--	5.5	23.1	44.0	67.1	37	U.A.S.S.
	10/2/73	150-298	148	540	--	7.2	23.1	44.0	67.1	58	A.L.S.
	10/2/73	220-298	78	920	--	6.9	23.1	44.0	67.1	95	L.A.S.S.
B-27	11/8/73	35-245	210	410	24.5	3.5	23.1	24.5	47.6	30	A.L.S.
	11/8/73	60-245	185	460	24.5	2.8	23.1	24.5	47.6	27	A.L.S.
	11/8/73	80-245	165	500	24.5	2.3	46.2	24.5	70.7	16	A.L.S.
	11/8/73	100-245	145	550	24.5	1.1	46.2	24.5	70.7	9	A.L.S.
	11/8/73	120-245	125	620	24.5	0.8	46.2	24.5	70.7	7	L.A.S.S.
B-28	11/13/73	16-25	9	5300	41.0	8.7	23.1	21.5	44.6	1040	U.A.S.S.
	11/13/73	19-28	9	5300	41.0	8.8	23.1	24.5	41.6	980	U.A.S.S.

(Continued)

TABLE 2.5-17 (Continued)

Boring	Date	Test Section[1]	L^2 (feet)	C_p[3]	G.W. Depth	Q^4 (gpm)	H_p[5] (feet)	Hg[6] (feet)	H^7 (feet)	K^8 (ft/yr)	Geologic Horizon[9]
B-28 Continued	11/13/73	27-36	9	5300	41.0	3.1	23.1	32.5	55.6	298.0	U.A.S.S.
	11/13/73	41-50	9	5300	41.0	--	0	42.0	--	*	U.A.S.S.
	11/13/73	50-271	221	390	41.0	0.47	23.1	42.0	65.1	2.8	U.A.S.S.
	11/13/73	90-271	181	470	41.0	0.96	23.1	42.0	65.1	6.9	U.A.S.S.
B-29	11/12/73	30-335	305	290	37.0	2.5	23.1	38.0	61.1	11.9	U.A.S.S.
	11/12/73	40-335	295	300	37.0	0.21	46.2	38.0	84.2	0.75	U.A.S.S.
	11/12/73	50-335	285	305	37.0	0.76	69.3	38.0	107.3	2.2	U.A.S.S.
	11/12/73	80-335	255	340	37.0	4.45	92.4	38.0	130.4	11.6	U.A.S.S.
B-30	12/4/73	11-20	9	5300	44.0	11.3	23.1	16.5	39.6	1510.0	U.A.S.S.
	12/5/73	20-253.5	233.5	370	44.0	14.8	23.1	45.0	68.1	80.0	U.A.S.S.
	12/5/73	65-253.5	188.5	450	44.0	9.9	23.1	45.0	68.1	65.0	U.A.S.S.
	12/5/73	88-253.5	165.5	500	44.0	2.2	46.2	45.0	91.2	12.0	U.A.S.S.
	12/5/73	144-253.5	139.5	560	44.0	0.5	46.2	45.0	91.2	3.1	A.L.S.

(Continued)

TABLE 2.5-17 (Continued)

Boring	Date	Test Section[1]	L[2] (feet)	C_p[3]	G.W. Depth	Q[4] (gpm)	H_p[5] (feet)	Hg[6] (feet)	H[7] (feet)	K[8] (ft/yr)	Geologic Horizon[9]
B-31	11/1/73	82-91	9.0	5300	64.4	12.5	23.1	66.4	89.5	740	A.L.S.
	11/1/73	92-101	9.0	5300	64.4	12.0	23.1	66.4	89.5	711	A.L.S.
	11/1/73	101-110	9.0	5300	64.4	12.0	23.1	66.4	89.5	711	A.L.S.
	10/21/73	110-252	142.0	560	64.4	1.8	23.1	66.4	89.5	112	L.A.S.S.
B-34	10/30/73	45.5-54.5	9.0	5300	58.0	12.2	23.1	50.0	73.1	885	A.L.S.
	10/30/73	54.5-63.5	9.0	5300	58.0	12.1	23.1	59.0	82.1	781	A.L.S.
	10/30/73	56-65	9.0	5300	58.0	11.5	23.1	60.0	83.1	733	A.L.S.
	10/29/73	92.5-248	155.5	520	59.0	6.0	23.1	61.0	84.1	37	A.L.S., L.A.S.S.
	10/29/73	105-248	143.0	550	59.0	2.0	23.1	61.0	84.1	13	L.A.S.S.
	10/29/73	130-248	118.0	660	59.0	1.8	23.1	61.0	84.1	14	L.A.S.S.
	10/29/73	165-248	83.0	880	59.0	1.6	23.1	61.0	84.1	17	L.A.S.S.
	10/29/73	172-248	76.0	950	59.0	4.5	23.1	61.0	84.1	51	L.A.S.S.
B-35	10/27/73	51.5-284	232.5	375	10.0	6.2	23.1	11.5	34.6	67	A.L.S., L.A.S.S.
	--	62-284	--	--	--	--	--	--	--	--	

(Continued)

TABLE 2.5-17 (Continued)

Boring	Date	Test Section[1]	L[2] (feet)	C_p[3]	G.W. Depth	Q[4] (gpm)	H_p[5] (feet)	Hg[6] (feet)	H[7] (feet)	K[8] (ft/yr)	Geologic Horizon[9]
B-35 Continued	10/27/73	95-284	189.0	450	17.0	4.9	23.1	18.5	41.6	53.0	L.A.S.S.
	10/26/73	130-284	154.0	525	27.0	4.8	23.1	28.5	51.6	49.0	L.A.S.S.
	10/27/73	169-284	115.0	670	27.0	3.3	23.1	28.5	51.6	42.0	L.A.S.S.
	10/27/73	218-284	66.0	1080	27.0	2.7	23.1	28.5	51.6	57.0	L.A.S.S.
	10/27/73	238-284	46.0	1450	27.0	2.0	46.2	28.5	74.7	39.0	L.A.S.S. KNOX
B-36	11/1/73	36.5-274.5	238.0	365	77.0	3.9	46.2	77.0	123.2	12.0	L.A.S.S.
	11/1/73	50-274.5	224.5	385	77.0	4.4	46.2	77.0	123.2	14.0	L.A.S.S.
	11/1/73	70-274.5	204.5	420	77.0	3.1	46.2	77.0	123.2	11.0	L.A.S.S.
	11/1/73	90-274.5	184.5	460	77.0	2.6	46.2	77.0	123.2	10.0	L.A.S.S.
	11/1/73	110.274.5	164.5	500	77.0	3.0	46.2	77.0	123.2	12.0	L.A.S.S.
B-39	11/9/73	20-29	9.0	5300	38.6	4.0	46.2	41.6	87.8	242.0	U.A.S.S.
	11/8/73	28.5-329	300.5	290	38.6	7.5	23.1	41.6	64.7	33.5	U.A.S.S.
	11/8/73	50-329	279.0	310	38.6	5.5	23.1	41.6	64.7	26.4	U.A.S.S.
	11/8/73	65-329	264.0	330	38.6	5.1	23.1	41.6	64.7	26.0	U.A.S.S.
	11/8/73	85-329	244.0	360	38.6	1.03	46.2	41.6	87.8	4.2	U.A.S.S.
	11/8/73	85-329	244.0	360	38.6	2.32	69.3	41.6	110.9	7.5	U.A.S.S.

(Continued)

TABLE 2.5-17 (Continued)

Boring	Date	Test Section[1]	L[2] (feet)	C_p[3]	G.W. Depth	Q[4] (gpm)	H_p[5] (feet)	Hg[6] (feet)	H[7] (feet)	K[8] (ft/yr)	Geologic Horizon[9]
B-40	9/25/73	30-39	9.0	5300	--	9.8	23.1	36.5	59.6	871	A.L.S.
	9/25/73	36-45	9.0	5300	--	5.8	23.1	42.5	65.6	471	A.L.S.
	9/25/73	46-55	9.0	5300	--	9.1	23.1	52.5	75.6	637	A.L.S.
	9/25/73	57.5-66.5	9.0	5300	--	2.1	23.1	64.0	87.1	128	A.L.S.
	9/25/73	68.5-77.5	9.0	5300	82.0	9.5	23.1	83.8	106.9	470	A.L.S.
	9/24/73	81-90	9.0	5300	77.0	2.0	46.2	79.0	125.2	85	A.L.S.
	9/24/73	91-100	9.0	5300	77.0	0.5	23.1	79.0	102.1	26	A.L.S.
	9/24/73	101-110	9.0	5300	80.0	2.1	23.1	82.0	105.1	108	A.L.S.
	9/23/73	110-314	204.0	420	76.0	5.5	46.2	77.8	124.0	19	L.A.S.S.
	9/23/73	140-314	174.0	480	76.5	6.1	23.1	78.5	101.6	29	L.A.S.S.
	9/23/73	184-314	130.0	600	76.0	6.1	23.1	78.0	101.1	36	L.A.S.S.
	9/23/73	220-314	94.0	800	81.0	5.2	23.1	83.0	106.1	39	L.A.S.S.
	9/23/73	259.5-314	54.5	1250	81.0	3.2	23.1	83.0	106.1	38	KNOX
B-42	11/5/73	60-301.5	241.5	360	78.0	2.92	23.1	78.0	101.1	10	B
	11/5/73	85-301.5	216.5	400	78.0	0.0	--	--	--	0	B
	11/5/73	140-301.5	161.5	500	78.0	1.22	23.1	78.0	101.1	6	B, U.A.S.S.
	11/5/73	150-301.5	151.5	530	78.0	1.54	23.1	78.0	101.1	8	U.A.S.S.

(Continued)

TABLE 2.5-17 (Continued)

Boring	Date	Test Section[1]	L[2] (feet)	C_p[3]	G.W. Depth	Q[4] (gpm)	H_p[5] (feet)	Hg[6] (feet)	H[7] (feet)	K[8] (ft/yr)	Geologic Horizon[9]
B-46	11/6/73	30-78.9	48.9	1380	53.8	6.24	23.1	54.8	77.9	111	U.A.S.S.
	11/6/73	65-78.9	13.9	3900	53.8	0.15	46.2	54.8	101.0	6	U.A.S.S.
B-47	12/4/73	83-92	9.0	5300	59.6	6.0	23.1	60.6	83.7	380	A.L.S.
	12/3/74	89-98	9.0	5300	59.6	4.8	23.1	60.6	83.7	304	A.L.S.
	12/3/73	98-107	9.0	5300	59.6	11.0	23.1	60.6	83.7	697	A.L.S.
	11/30/73	108-370	262.0	340	59.6	3.7	23.1	60.6	83.7	15	L.A.S.S.
	11/30/73	115-370	255.0	340	59.6	3.1	46.2	60.6	106.8	10	L.A.S.S.
	11/30/73	140-370	230.0	380	59.6	1.1	46.2	60.6	106.8	4	L.A.S.S.
	11/30/73	150-370	220.0	400	59.6	1.2	46.2	60.6	106.8	4	L.A.S.S.
B-48	9/20/73	33-114	81.0	900	29.3	2.5	23.1	29.3	52.4	43	B
	9/20/73	43-114	71.0	1000	30.0	1.4	23.1	30.0	53.1	27	B
	--	56-114	58.0	1200	37.8	0.7	23.1	37.8	60.9	14	B
	9/17/73	85-114	29.0	2000	44.5	0.5	23.1	45.5	68.6	15	U.A.S.S.

(Continued)

TABLE 2.5-17 (Continued)

Boring	Date	Test Section[1]	L[2] (feet)	C_p[3]	G.W. Depth	Q[4] (gpm)	H_p[5] (feet)	Hg[6] (feet)	H[7] (feet)	K[8] (ft/yr)	Geologic Horizon[9]
B-49	11/7/73	57.5-144	86.5	860	68.8	10.8	23.1	71.8	94.9	98	B
	11/7/73	70-144	74.0	980	68.8	2.2	46.2	71.8	118.0	18	B
	11/7/73	85-144	59.0	--	--	0.0	46.2	71.8	--	0	B
	11/6/73	110-144	34.0	--	--	0.0	115.5	71.8	--	0	U.A.S.S.
B-50	11/2/73	78-241	163.0	500	66.0	2.7	23.1	68.0	91.1	15	B
	11/2/73	90-241	151.0	535	66.0	2.6	23.1	68.0	91.1	15	B
	11/2/73	100-241	141.0	560	66.0	2.6	23.1	68.0	91.1	16	B
	11/2/73	201-241	40.0	1650	66.0	1.4	23.1	68.0	91.1	25	U.A.S.S.
B-51	11/20/73	31-40	9.0	5300	57.0	1.0	23.1	37.5	60.6	91	A.L.S.
	11/20/73	36.5-45.5	9.0	5300	57.0	0.46	23.1	43.0	66.1	37	A.L.S.
	11/20/73	45.5-54.5	9.0	5300	57.0	0.11	23.1	52.0	75.1	8	A.L.S.
	11/20/73	34.5-63.5	9.0	5300	57.0	17.2	23.1	59.0	82.1	1110	A.L.S.
	11/20/73	83-338.5	255.5	340	57.0	2.67	46.2	59.0	105.2	9	A.L.S.
	11/20/73	100-338.5	238.5	365	57.0	1.86	46.2	59.0	105.2	6	A.L.S., L.A.S.S.

(Continued)

TABLE 2.5-17 (Continued)

Boring	Date	Test Section[1]	L[2] (feet)	C_p[3]	G.W. Depth	Q[4] (gpm)	H_p[5] (feet)	Hg[6] (feet)	H[7] (feet)	K[8] (ft/yr)	Geologic Horizon[9]
B-53	11/29/73	53-200	147.0	540	84.0	0.15	46.2	85.5	131.7	0.6	KNOX
	11/29/73	90-200	110.0	700	84.0	0.15	23.1	85.5	108.6	1.0	KNOX
B-66	11/29/73	37-101	64.0	1100	44.7	0.12	46.2	46.7	92.9	1.4	KNOX
	11/29/73	50-101	51.0	1350	44.7	0.08	46.2	46.7	92.9	1.2	KNOX
	11/29/73	73-101	28.0	2200	44.7	0.12	46.2	46.7	92.9	2.8	KNOX
B-67	11/17/73	20-29	9.0	5300	35.0	--	--	--	--	*	KNOX
	11/17/73	24-33	9.0	5300	35.0	0.08	46.2	30.1	76.3	5.6	KNOX
	11/17/73	33-42	9.0	5300	35.0	0.0	--	--	--	0.0	KNOX
	11/17/73	42-51	9.0	5300	35.0	0.0	--	--	--	0.0	KNOX
	11/17/73	51-60	9.0	5300	35.0	9.1	23.1	36.6	59.7	807.0	KNOX
	11/16/73	40-100	60.0	1180	35.0	9.2	23.1	36.6	59.7	182.0	KNOX
	11/15/73	61-100	39.0	--	35.0	0.0	--	--	--	0.0	KNOX

*Take in Test Section Exceeded Capacity of Test Equipment

(Continued)

TABLE 2.5-17 (Continued)

1. Test Section = first number indicates top level and second number indicates bottom level of test section.

2. L = length of test section (ft)

3. Cp = coefficient of permeability

4. Q = average inflow (gpm)

5. Hp = pumphead (ft)

6. Hg = gravity head (ft)

7. H = Hp + Hg

8. K = Permeability - ($K = Cp \frac{Q}{H}$)

9. Geologic Horizon

   U.A.S.S. - Upper Unit A Siltstone

   L.A.S.S. - Lower Unit A Siltstone

   A.L.S. - Unit A Limestone

   B. - Unit B Limestone

TABLE 2.5-18

SUMMARY OF WELL SURVEY DATA

Map* Ident. No.	Location Latitude	Location Longitude	Well Depth (feet)	Estimated Elev. (feet) Ground	Estimated Elev. (feet) Water Surf.	Well Dia. (feet)	Remarks
1	35° 53' 36"	84° 24' 52"	206	830	730	.5	1 gpm
2	35° 53' 39"	84° 24' 49"	80	835	825	.5	
3	35° 53' 35"	84° 24' 51"	80	830	795	4.0	1/2 hp pump
4	35° 53' 38"	84° 24' 47"	75	830	812	.5	1/3 hp pump
5	35° 53' 36"	84° 24' 44"	65	825	805	.5	
6	35° 53' 36"	84° 24' 46"	40	820	803	.5	2 gpm
7	35° 53' 34"	84° 24' 53"	40	830	820	.5	1 house, 2 mobile
8	35° 53' 31"	84° 24' 51"	80	820	790	.5	
9	35° 53' 33"	84° 24' 55"	100	825	795	.5	
10	35° 53' 33"	84° 24' 57"	90	830	810	.5	1 house, 2 businesses
11	35° 53' 30"	84° 24' 58"	65	825	810	.5	1/3 hp pump
12	35° 53' 28"	84° 24' 56"	68	822	807	.5	1/4 hp pump
13	35° 53' 26"	84° 24' 59"	125	825	815	.5	16 mobile homes
14	35° 53' 38"	84° 24' 43"	185	825	810	.5	10 gpm
15	35° 53' 39"	84° 24' 46"	75	820	800	.5	1/2 hp pump
16	35° 53' 40"	84° 24' 45"	85	815	805	.5	
17	35° 53' 41"	84° 24' 39"	67	800	780	.5	3 gpm
18	35° 53' 45"	84° 24' 42"	42	830	815	.5	1 house, 1 mobile home
19	35° 53' 43"	84° 24' 35"	100	805	745	.5	
20	35° 53' 51"	84° 24' 34"	28	830	825	4.0	garden use only
21	35° 53' 50"	84° 24' 34"	185	825	815	.5	1 house, 1 mobile home
22	35° 53' 49"	84° 24' 25"	47	825	795	.5	
23	35° 53' 52"	85° 24' 19"	50	800	770	3.0	house, service station
24	35° 53' 58"	84° 24' 22"	55	810	790	.5	1/2 hp pump
25	35° 53' 56"	84° 24' 24"	85	825	795	.5	10 gpm

(Continued)

TABLE 2.5-18 (Continued)

Map* Ident. No.	Location Latitude	Location Longitude	Well Depth (feet)	Estimated Elev. (feet) Ground	Estimated Elev. (feet) Water Surf.	Well Dia. (feet)	Remarks
26	35° 53' 59"	84° 24' 16"	125	805	720	.5	1/3 hp pump
27	35° 54' 05"	84° 23' 56"	65	770	755	.5	1/2 hp pump
28	35° 54' 06"	84° 23' 53"	65	765	755	.5	
29	35° 54' 10"	84° 23' 51"	110	780	765	.5	
30	35° 54' 13"	84° 23' 47"	125	775	765	.5	3/4 hp pump
31	35° 54' 16"	84° 23' 41"	75	765	725	.5	3/4 gpm
32	35° 53' 56"	84° 23' 58"	50	780	740	.5	3 gpm
33-S	35° 53' 57"	84° 24' 00"		752			spring, 3 gpm
34	35° 53' 57"	84° 23' 54"	75	765	715	.5	
35	35° 54' 04"	84° 23' 39"	98	800	770	.5	5 gpm
36	35° 54' 08"	84° 23' 36"	125	790	755	.5	5 gpm
37	35° 54' 10"	84° 23' 30"	90	810	760	.5	5 gpm
38	35° 53' 18"	84° 24' 16"	110	980	950	.5	5 gpm
39	35° 53' 35"	84° 25' 45"	60	820	805	.5	1/3 hp pump
40	35° 53' 34"	84° 24' 43"	108	805	790	.5	3/4 hp pump
41	35° 53' 32"	84° 24' 43"	85	795	790	.5	1/3 hp pump
42	35° 53' 28"	84° 24' 43"	65	795	735	.5	1/3 hp pump
43	35° 53' 25"	84° 24' 38"	150	840	790	.5	
44-S	35° 53' 20"	84° 24' 39"		820			spring, 5 gpm
45-S	35° 53' 05"	84° 24' 43"		845			spring
46	35° 53' 12"	84° 24' 15"	340	970	820	.5	
47	35° 52' 55"	84° 24' 13"	125	880		.5	3/4 hp pump
48	35° 52' 52"	84° 24' 07"	50	820	800	.5	
49-S	35° 52' 51"	84° 24' 14"		800			spring
50-S	35° 52' 46"	84° 24' 07"		795			spring

(Continued)

TABLE 2.5-18 (Continued)

Map* Ident. No.	Location: Latitude	Location: Longitude	Well Depth (feet)	Estimated Elev. (feet): Ground	Estimated Elev. (feet): Water Surf.	Well Dia. (feet)	Remarks
51-S	35° 52' 55"	84° 24' 18"		820			spring
52	35° 52' 47"	84° 23' 53"	200	800	740	.5	1/2 hp pump
53	35° 52' 50"	84° 23' 49"	104	800	790	.5	
54-S	35° 53' 03"	84° 23' 43"		800			spring
55	35° 53' 06"	84° 23' 30"	137	810	710	.5	1 hp pump
56	35° 52' 59"	84° 23' 34"	90	760		.5	
57	35° 52' 40"	84° 23' 55"	104	885	880	.5	3/4 hp pump
58-S	35° 52' 36"	84° 23' 42"		800			spring, 6 gpm
59	35° 52' 47"	84° 23' 33"		770		.5	
60	35° 52' 50"	84° 23' 29"	200	770	730	.5	
61	35° 52' 38"	84° 24' 43"	141	862	825	.5	
62	35° 52' 38"	84° 24' 08"	128	815	745	.5	
63	35° 52' 37"	84° 22' 43"	115	805	805	.5	1 hp pump
64	35° 52' 44"	84° 23' 34"	330	822	520	.5	1.5 hp pump
66	35° 52' 25"	84° 22' 45"	195	809		.5	3 houses
67	35° 52' 24"	84° 22' 44"	185	790		.5	business; 1 hp pump
68	35° 52' 21"	84° 22' 40"	125	800	770	.5	
69	35° 52' 20"	84° 22' 40"	300	782		.5	business
70	35° 52' 20"	84° 22' 39"	700	782		.5	business
71	35° 52' 22"	84° 22' 33"	200	800	780	.5	location of wells 71,72
72	35° 52' 22"	84° 22' 33"	155	800	800	.5	73 approximate.
73	35° 52' 22"	84° 22' 33"	250	800	760	.5	Supply for commercial Campground
74	35° 52' 25"	84° 22' 55"	250	800	735	.5	2 houses; 1 hp pump
75	35° 52' 25"	84° 22' 58"	150	788	786	.5	
76	35° 52' 29"	84° 22' 58"	220	830		.5	

(Continued)

TABLE 2.5-18 (Continued)

Map* Ident. No.	Location: Latitude	Location: Longitude	Well Depth (feet)	Estimated Elev. (feet): Ground	Estimated Elev. (feet): Water Surf.	Well Dia. (feet)	Remarks
77	35° 52' 23"	84° 24' 07"	260	770	645	.5	
78-S	35° 52' 20"	84° 23' 56"		870			spring, 7 gpm
79	35° 52' 27"	84° 23' 03"	102	840		.5	1 hp pump
80	35° 52' 23"	84° 23' 02"		840			
81	35° 52' 25"	84° 23' 07"	200	854	854	.5	2 houses, 1/2 hp pump
82	35° 52' 19"	84° 23' 16"	212	851	851	.5	1 hp pump
83	35° 52' 17"	84° 23' 21"	196	867	867	.5	3 houses, church
84-S	35° 52' 12"	84° 23' 33"		840			spring, 10 gpm
85-S	35° 52' 06"	84° 23' 45"		860			spring, 3 gpm
86-S	35° 52' 03"	84° 23' 49"		850			spring, 4 gpm
87	35° 51' 57"	84° 23' 45"	136	856		.5	
88	35° 51' 42"	84° 23' 03"	125	785		.5	
89	35° 51' 46"	84° 23' 57"	101	820	795	.5	1/2 hp pump
90	35° 52' 11"	84° 22' 41"	120	760		.5	1 hp pump
91	35° 52' 05"	84° 22' 55'	250	770	755	.5	business
92-S	35° 51' 57"	84° 24' 02"		875			spring, 3 gpm
93-S	35° 52' 30"	84° 21' 51"		860			spring, 7 gpm
94-S	35° 52' 41"	84° 21' 26"		960			spring, 5 gpm
95-S	35° 52' 45"	84° 21' 08"		955			spring, 4 gpm
96	35° 52' 52"	84° 21' 47"	65	825	800	.5	1/2 hp pump
97-S	35° 53' 10"	84° 22' 01"		850			spring, 2 gpm
98-S	35° 53' 10"	84° 22' 00"		850			spring, 1/4 gpm
99	35° 53' 18"	84° 22' 11"		775			
100	35° 53' 36"	84° 22' 05"	21	795	780	3.0	2 houses, 1.5 hp pump
101	35° 53' 35"	84° 22' 10"	340	790	730	.33	1 hp pump

(Continued)

TABLE 2.5-18 (Continued)

Map* Ident. No.	Location		Well Depth (feet)	Estimated Elev. (feet)		Well Dia. (feet)	Remarks
	Latitude	Longitude		Ground	Water Surf.		
102	35° 53' 01"	84° 20' 40"	45	790	770	.5	
103	35° 53' 32"	84° 21' 30"		780			
104-S	35° 52' 11"	84° 22' 14"		935			spring, 3 gpm
105	35° 52' 18"	84° 22' 11"		805			
106-S	35° 52' 16"	84° 22' 05"		985			spring, 6 gpm
107	35° 52' 11"	84° 21' 29"	350	1100		.5	1 hp pump
108	35° 52' 13"	84° 21' 51"	235	1130			
109	35° 52' 01"	84° 21' 46"	175	1045	950	.5	1/2 hp pump
110	35° 51' 47"	84° 22' 03"	205	1035	950	.5	3/4 hp pump

*Identifying map numbers correspond to Figure 2.5-12

TABLE 2.5-19

DATA ON PUBLIC GROUND WATER SUPPLIES WITHIN A 20-MILE RADIUS OF THE SITE
(Map Reference Numbers Correspond to Figure 2.5-13)

Water Supply	Approximate Radial Distance From Site (miles)	Estimated Population Served	Average Daily Use (gallons)	Source	Map* Reference Number
Public Supplies					
Bushy Mountain State Honor Farm	17.9	195	60,000	Well	1
Cumberland Utility District**	6.7	5,000	212,000	Spring	2
Dixie Lee Utility District[+]	8.6	4,500	395,000	Spring	3
Dutch Valley Elementary School	16.8	140	3,500	Well	4
Edgewood Elementary School	3.5	196	4,900	Well	5
First Utility District of Anderson County	17.1	3,600	270,000	Spring	6
Kingston[++]	8.8	5,000	315,000	Spring	7
Loudoun	11.4	5,000	489,000	Spring	8
Midtown	10.8	2,090	130,000	Well	9
Midway High School	12.6	515	12,900	Spring	10
Oliver Springs	12.5	3,570	188,000	Spring	11
Paint Rock Elementary School	12.4	250	6,200	Well	12
Philadelphia Elementary School	14.5	300	7,700	Well	13
Piney Utility District	12.2	2,000	75,000	Spring	14
Plateau Utility District	17.7	1,900	100,000	Well	15
Rockwood	18	5,500	1,200,000	Spring[▽]	16
West Knox Utility District	17.8	18,000	1,000,000	Spring[▽]	17

(Continued)

TABLE 2.5-19 (Continued)

Water Supply	Approximate Radial Distance From Site (miles)	Estimated Population Served	Average Daily Use (gallons)	Source	Map* Reference Number
Industrial Supplies					
Charles H. Bacon Co., Loudoun[▽▽]	10.2	--	300,000	Spring[▽]	18
Charles H. Bacon Co., Lenoir City[▽▽]	9.8	--	255,000	Well	19
John J. Craig Company	13.8	--	34,600	Well[▽]	20
Lenoir City Car Works	9.3	--	30,000	Well	21
Morgan Apparel Co.	17.8	--	3,000	Well	22
Hosiery Mills	14.5	--	20,000	Well	23
Ralph Rogers Co., Inc.	11.4	--	24,000	Well	24

*Map reference numbers correspond to Figure 2.5-13

**Also has an auxiliary water intake at Little Emory River mile 3.9

[+]Includes Martil Utility District

[++]Also has an auxiliary water intake at Tennessee River mile 568.2

[▽]Also uses surface sources

[▽▽]Water supply is also used for potable water within the plant

TABLE 2.5-20

RESULTS OF CHEMICAL AND PHYSICAL TESTS OF GROUND-WATER QUALITY*
(Location of Wells is Shown in Figure 2.5-14)

Sample	B-1	B-27	B-27	B-29	B-37	B-37	B-41	A**	B**	C**	D**	E**	F**	G**	H**
Depth (or Formation)	100'	110'	150'	100'	100'	160'	100'	(Oεk)[+]	(εc)[+]	(Olmc)[+]	(Oεk)[+]	(Olv)[+]	(Olmc)[+]	(εc)[+]	(εr)[+]
pH	7.3	7.9	8.7	7.2	7.1	7.1	7.1	8.0	8.1	8.2	8.3	8.5	8.2	8.7	4.9
Conductivity (Micromhos)	300.0	450.0	500.0	475.0	475.0	550.0	375.0	300.0	230.0	168.0	217.0	349.0	205.0	333.0	240.0
Silica (SiO_2)	1.6	1.7	1.7	1.7	1.8	2.0	1.5								
Iron (Fe)	0.28	0.92	0.46	1.1	1.0	1.5	0.52	0.07	0.21	0.12	0.24	0.13	0.09	0.14	9.5
Total Hardness as $CaCO_3$	232.0	88.0	32.0	130.0	308.0	314.0	178.0	167.0	121.0	95.0	119.0	199.0	109.0	188.0	46.0
Calcium (Ca)	48.0	22.4	7.2	36.0	52.8	61.6	49.6	58.0	41.0	--	28.0	64.0	38.0	39.0	10.0
Magnesium (Mg)	27.2	7.8	3.4	9.7	42.8	38.9	13.1	5.4	4.6	--	12.0	9.5	3.5	22.0	5.1
Sodium (Na)	9.0	80.0	90.0	100.0	14.0	21.0	28.0								
Potassium	2.0	10.0	10.0	5.0	6.0	9.0	4.0								
Bicarbonate (HCO_3)	173.2	363.6	280.6	385.5	385.5	468.5	261.1	179.0	135.0	114.0	136.0	204.0	132.0	192.0	0.0
Carbonate (CO_3)	0.0	0.0	43.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	12.0	--
Sulfate (SO_4)	5.1	9.7	3.8	4.1	3.6	2.8	4.6	4.0	15.0	8.0	10.0	3.0	2.0	5.0	26.0
Chloride (Cl)	7.9	13.9	15.9	9.9	7.9	7.9	17.9	6.8	5.2	1.5	2.0	6.8	2.0	3.2	17.0
Fluoride (F)	0.0	1.74	1.74	0.0	0.26	0.0	0.52	0.0	0.0	0.0	0.0	0.0	0.0	0.1	--
Nitrate (N)	0.85	1.4	0.70	0.8	1.4	1.1	0.73	9.1	3.3	1.2					
Turbidity JTU	26.0	55.0	28.0	81.0	52.0	110.0	27.0								
Total Dissolved Solids	301.0	564.0	490.0	512.0	421.0	497.0	328.0								

*All results in parts per million except pH, Conductivity and Turbidity. Location of wells shown in Figure 2.5-14

**Data on wells A through H reproduced from Table 70, page 344, reference 12.

[+]Oεk=Knox, εc=Conasauga, Olmc=Chickamauga, Olv=Longview (Knox), εr=Rome

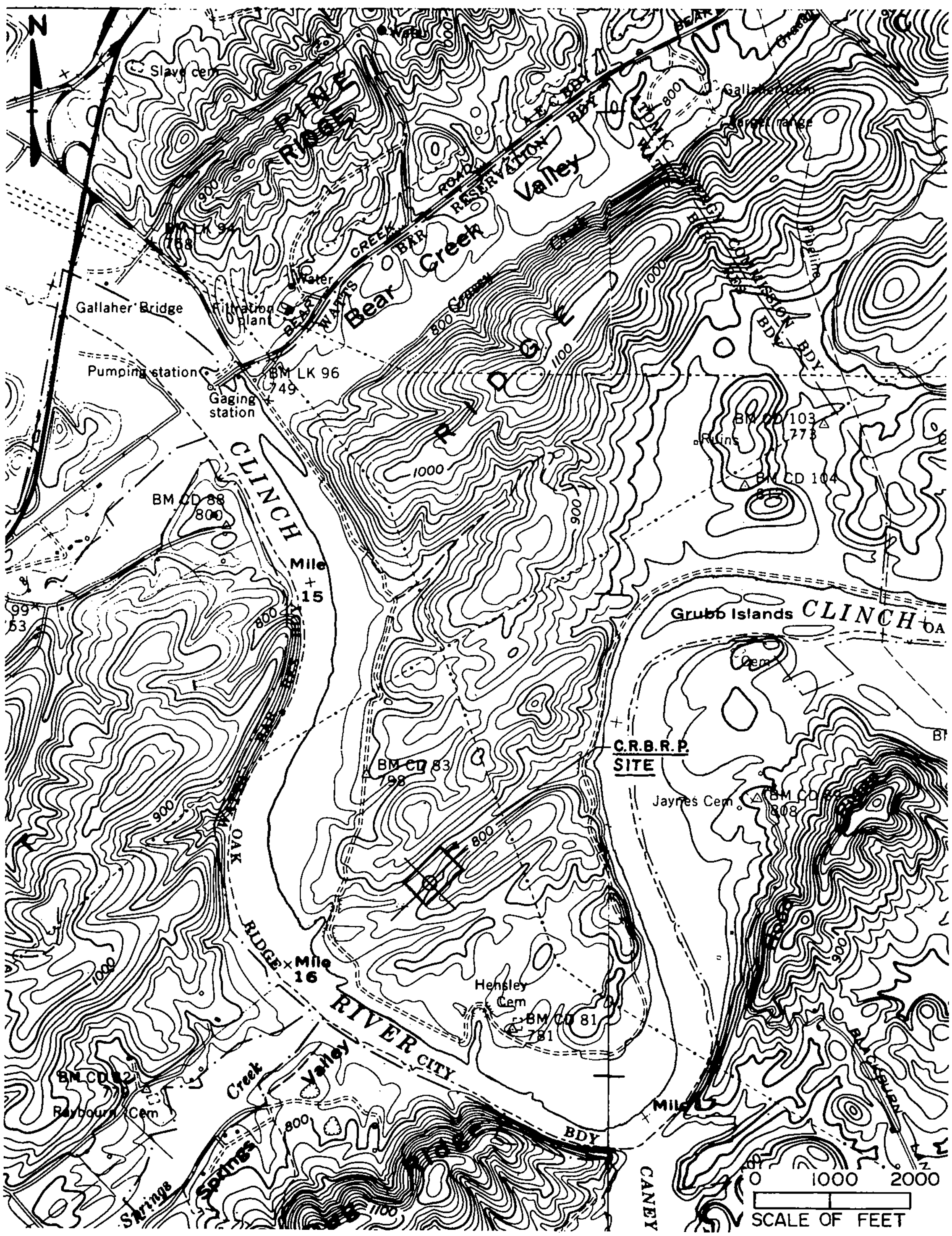


Figure 2.5-1 TOPOGRAPHY OF CLINCH RIVER SITE

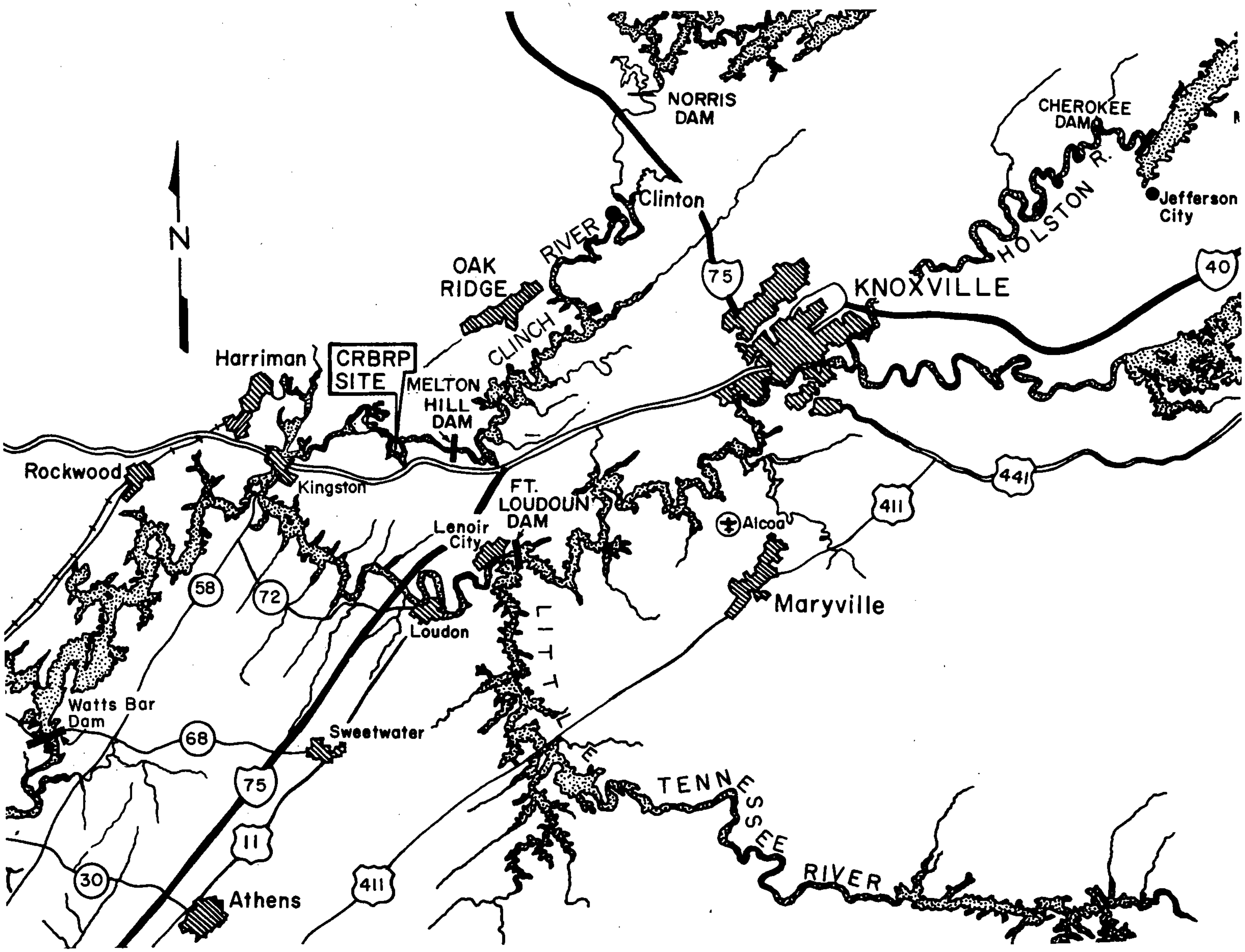


Figure 2.5-2 NORRIS, MELTON HILL, FORT LOUDOUN AND WATTS BAR DAMS

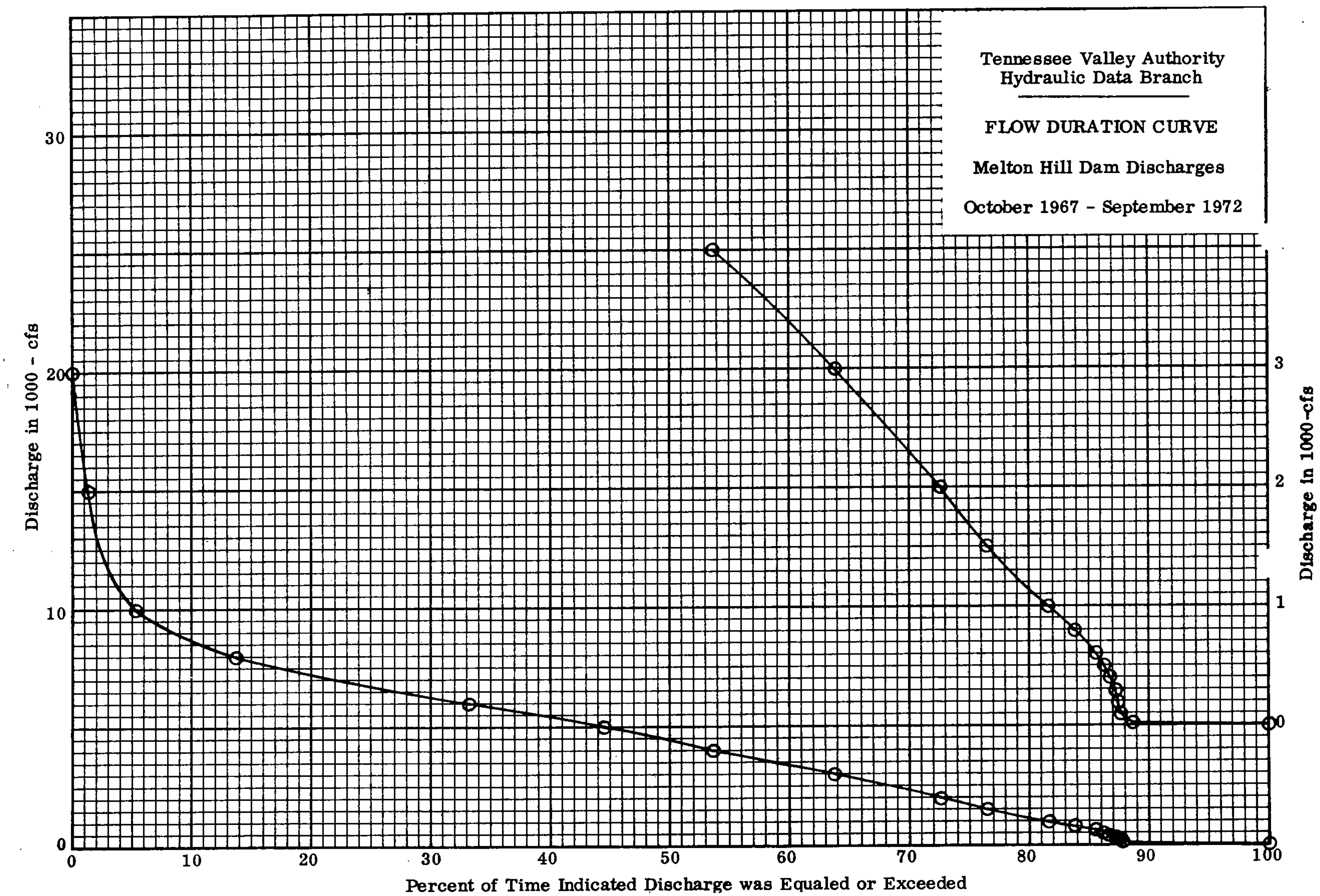


Figure 2.5-3 FLOW DURATION CURVE

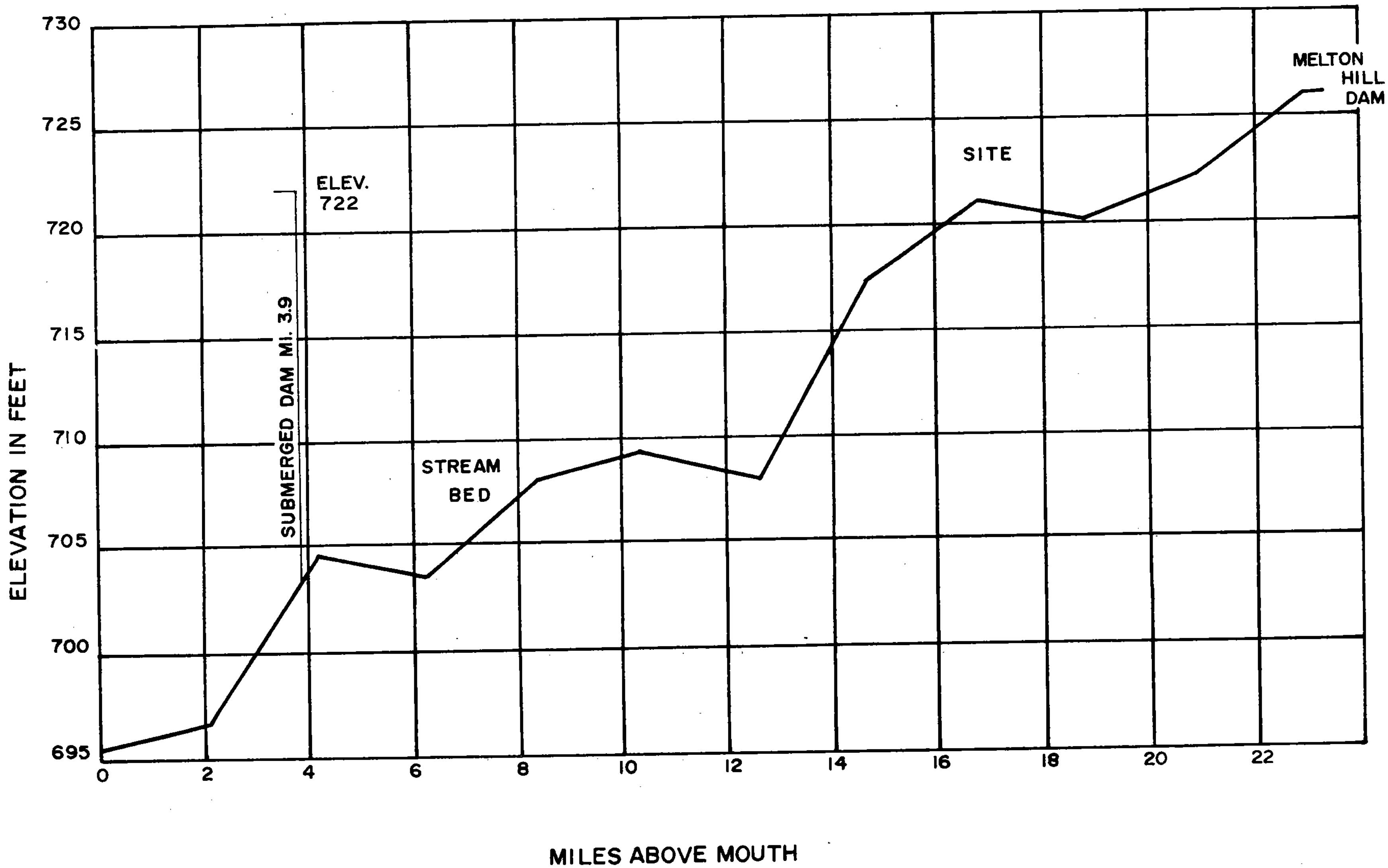


Figure 2.5-4 DOWNSTREAM PROFILE OF THE CLINCH RIVER

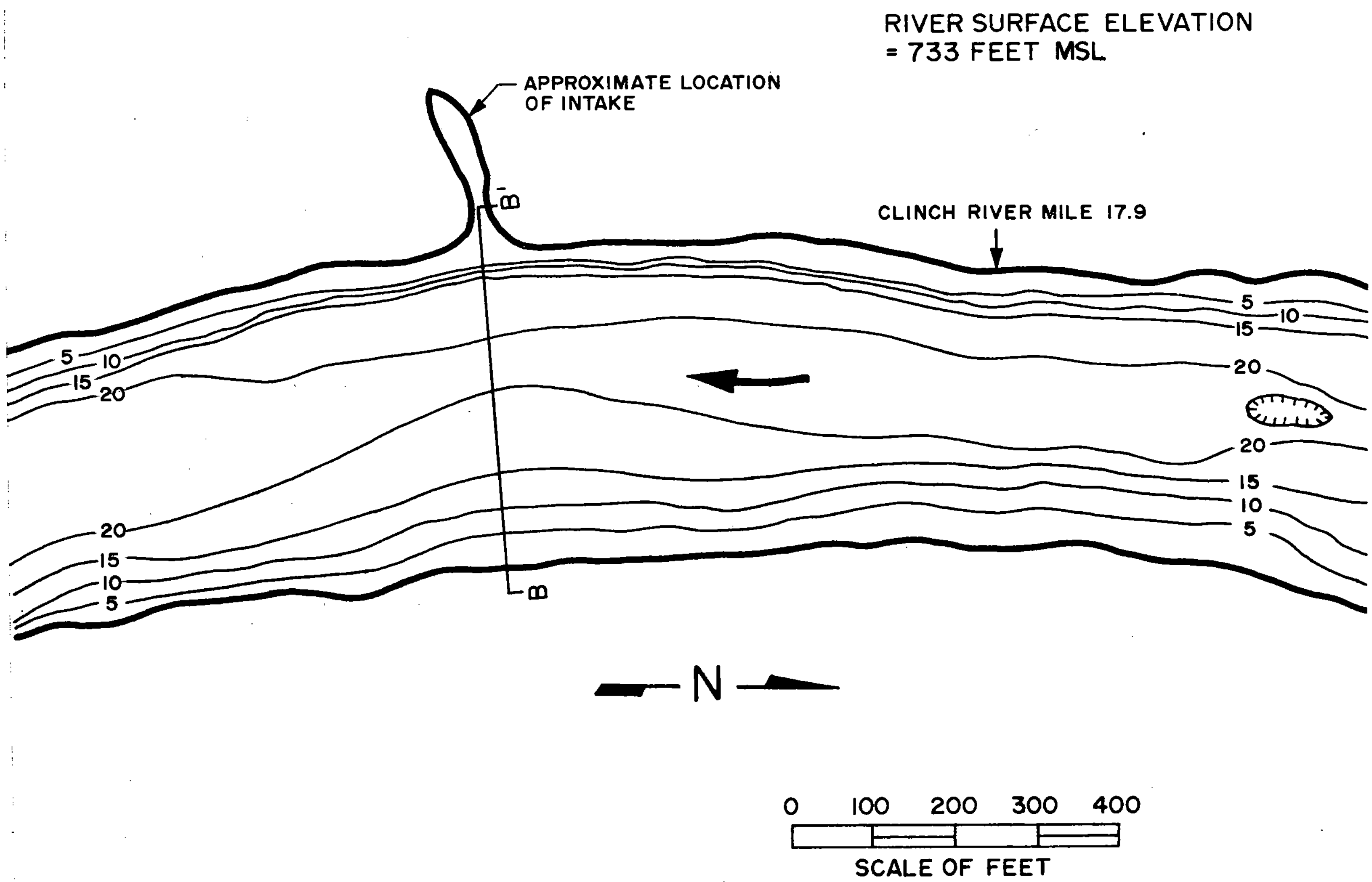


Figure 2.5-5 BATHYMETRIC CHART OF CLINCH RIVER IN THE VICINITY OF THE INTAKE

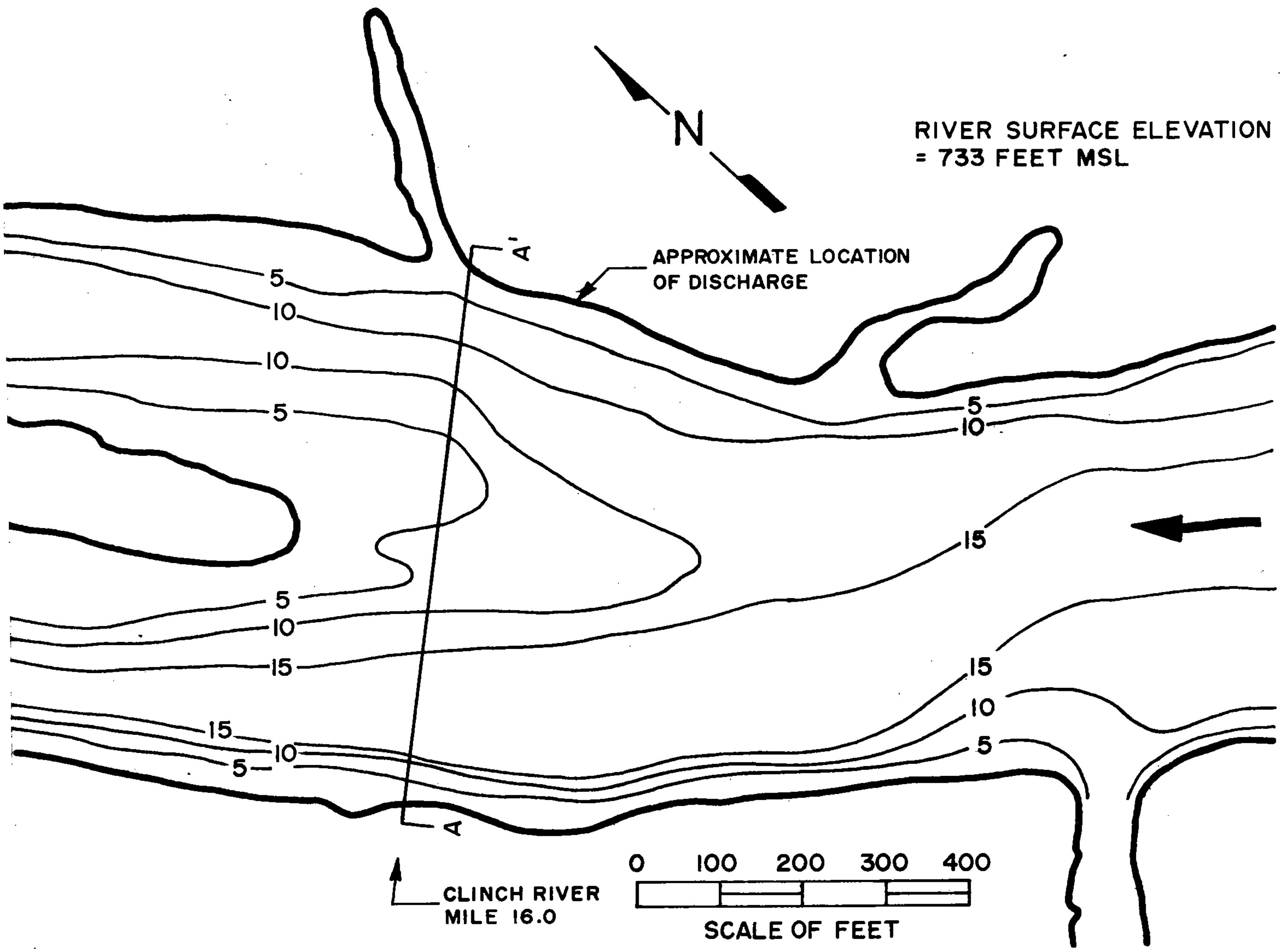


Figure 2.5-6 BATHYMETRIC CHART OF CLINCH RIVER IN THE VICINITY OF THE DISCHARGE

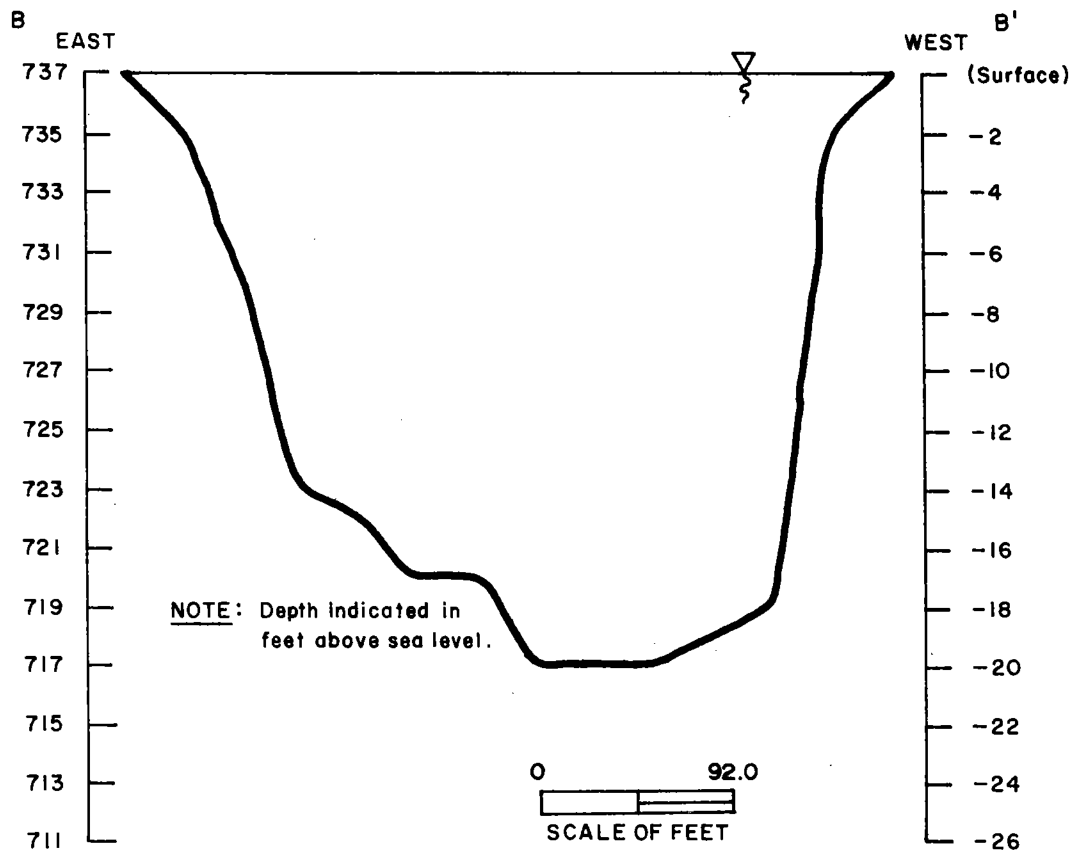


Figure 2.5-7 CROSS-SECTIONAL PROFILE OF CLINCH RIVER IN THE VICINITY OF THE INTAKE

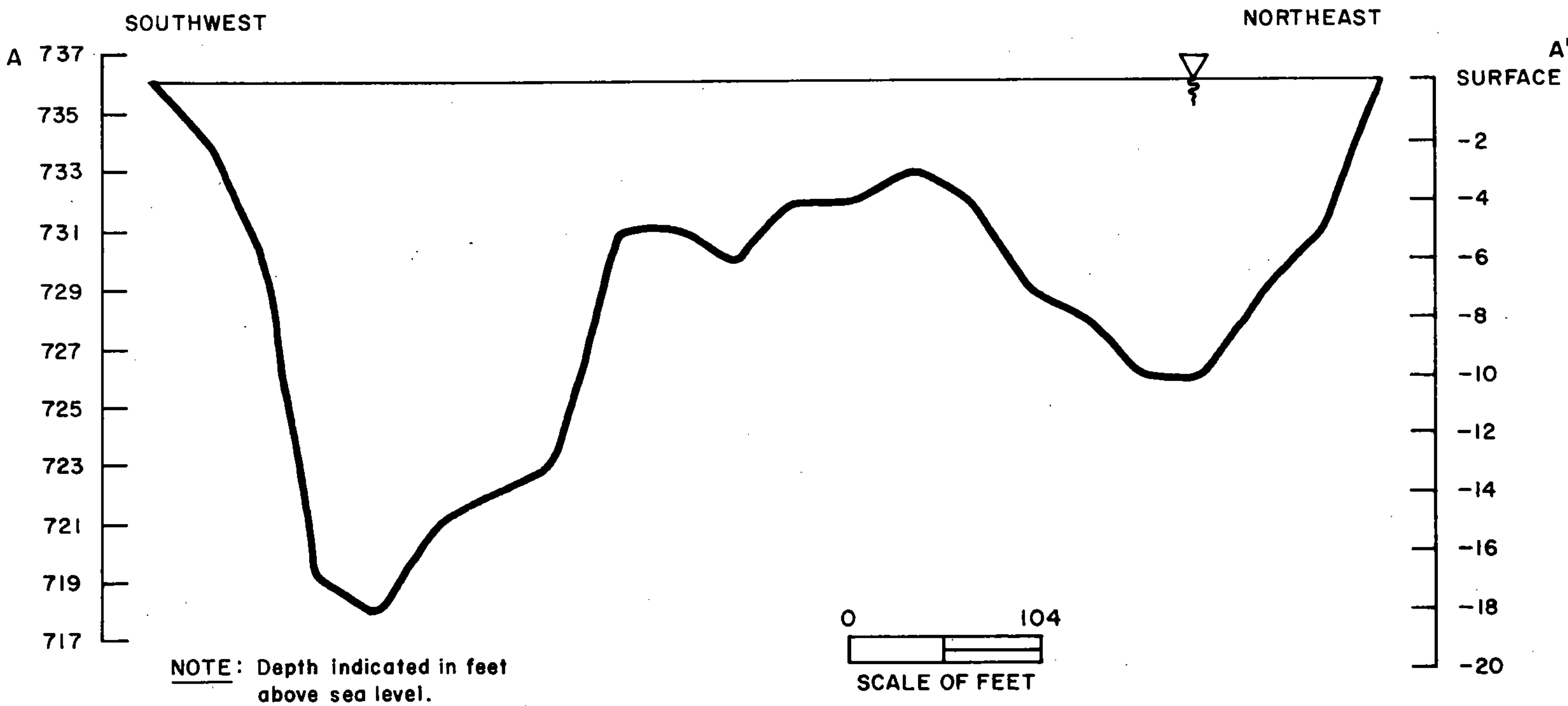
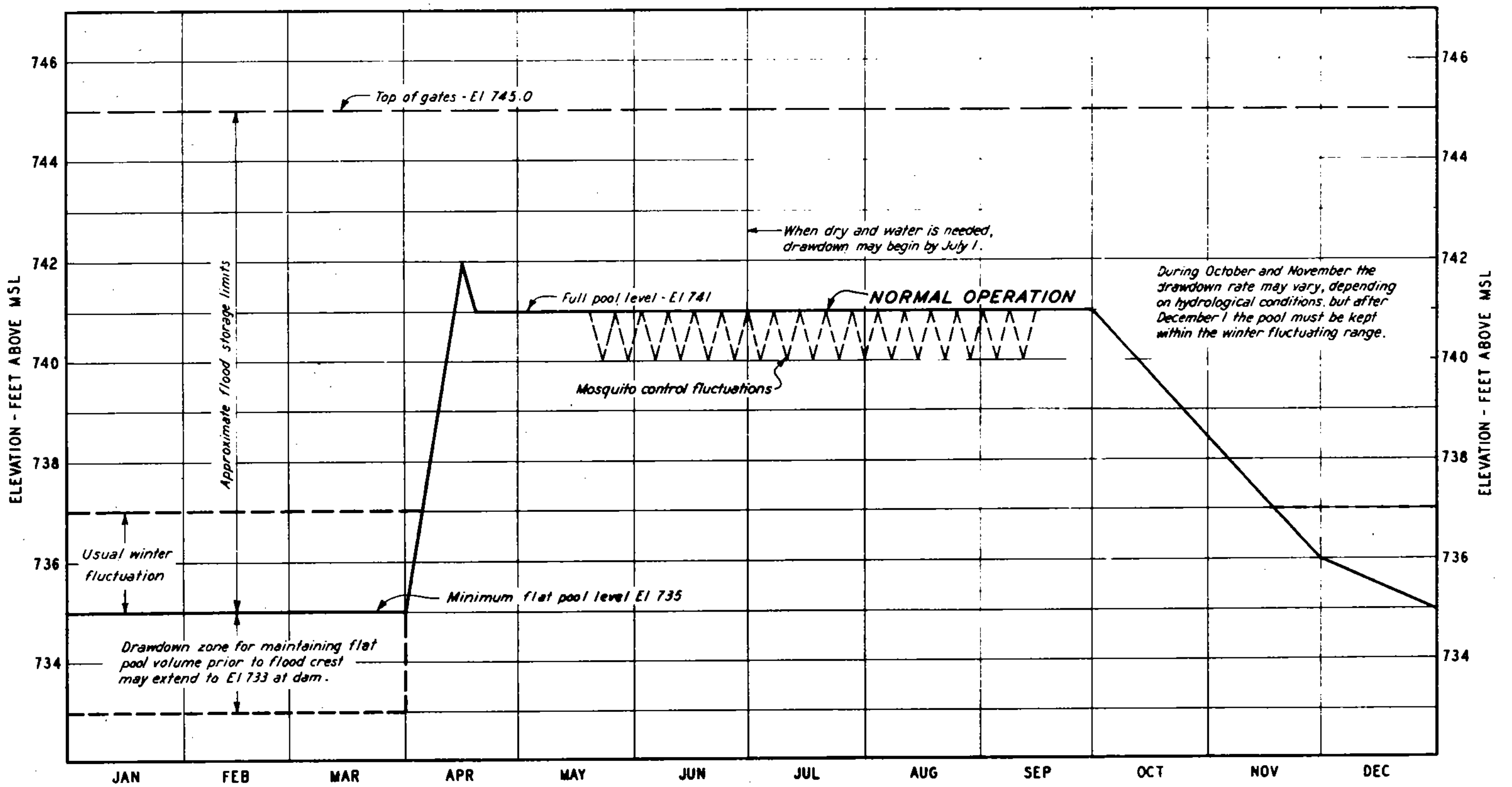


Figure 2.5-8 CROSS-SECTIONAL PROFILE OF CLINCH RIVER IN THE VICINITY OF THE DISCHARGE



NOTES:

(1) Elevations apply only at dam.
(2) Maximum level assumed for design of dam - El 745.0.

MULTIPLE-PURPOSE
RESERVOIR OPERATIONS

WATTS BAR PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

SUBMITTED	RECOMMENDED	APPROVED
[signature]	[signature]	[signature]
KNOXVILLE	3-29-45 9 RC 1	321G531R3

Figure 2.5-9 NORMAL OPERATING LEVEL FOR WATTS BAR RESERVOIR

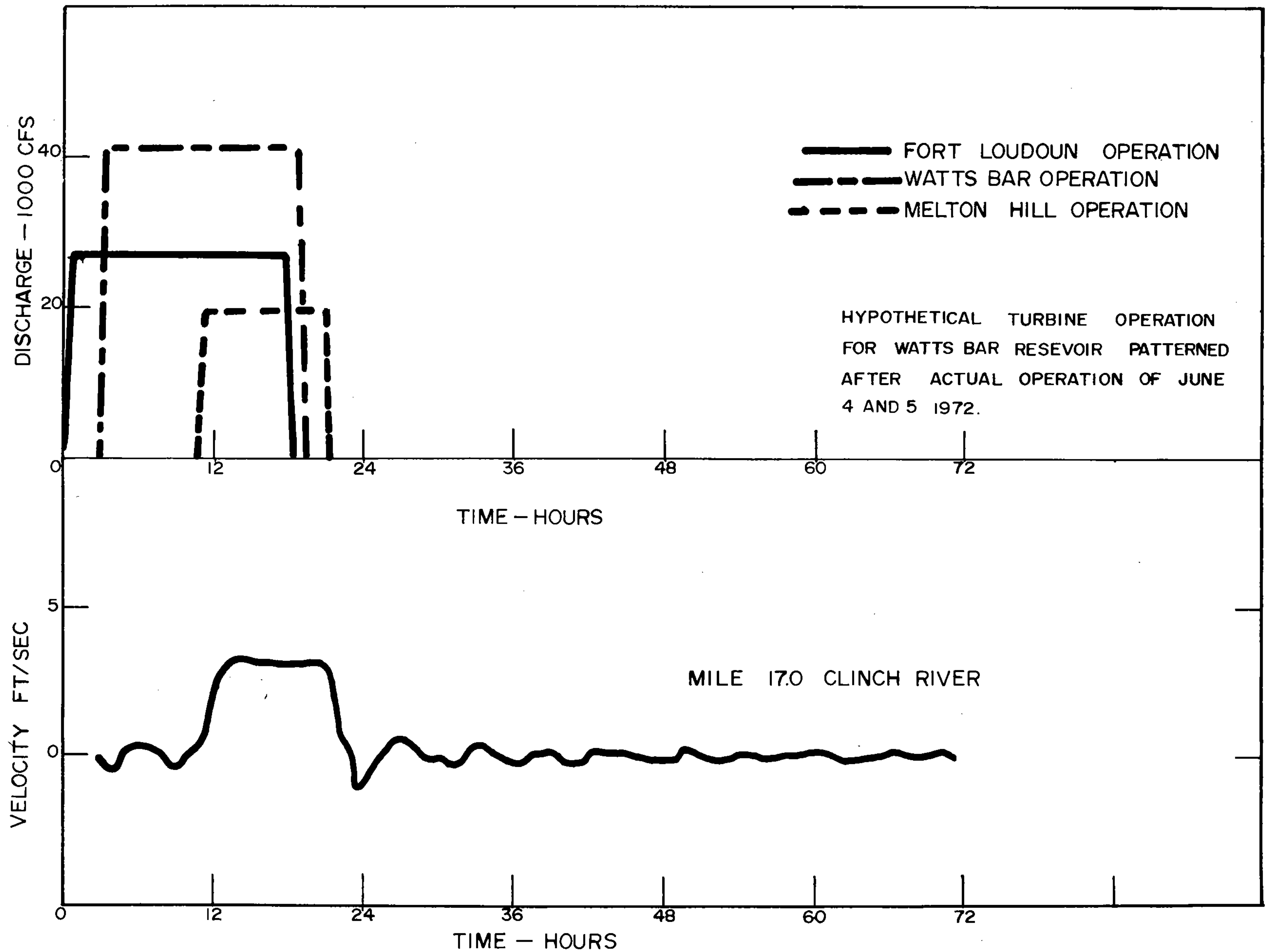


Figure 2.5-10 VELOCITY RESPONSE AT CRM 17 TO POSTULATED TURBINE OPERATIONS[11]

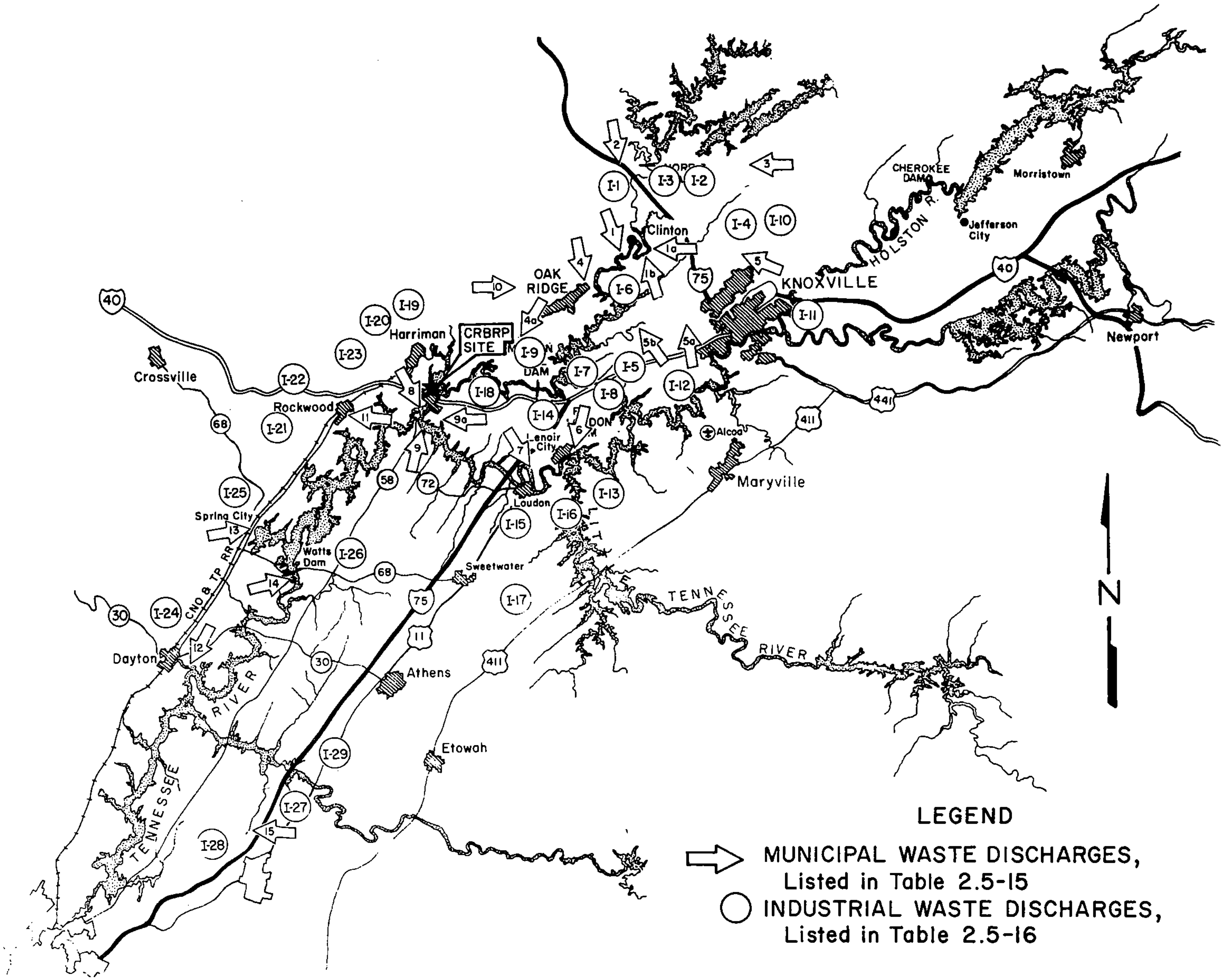
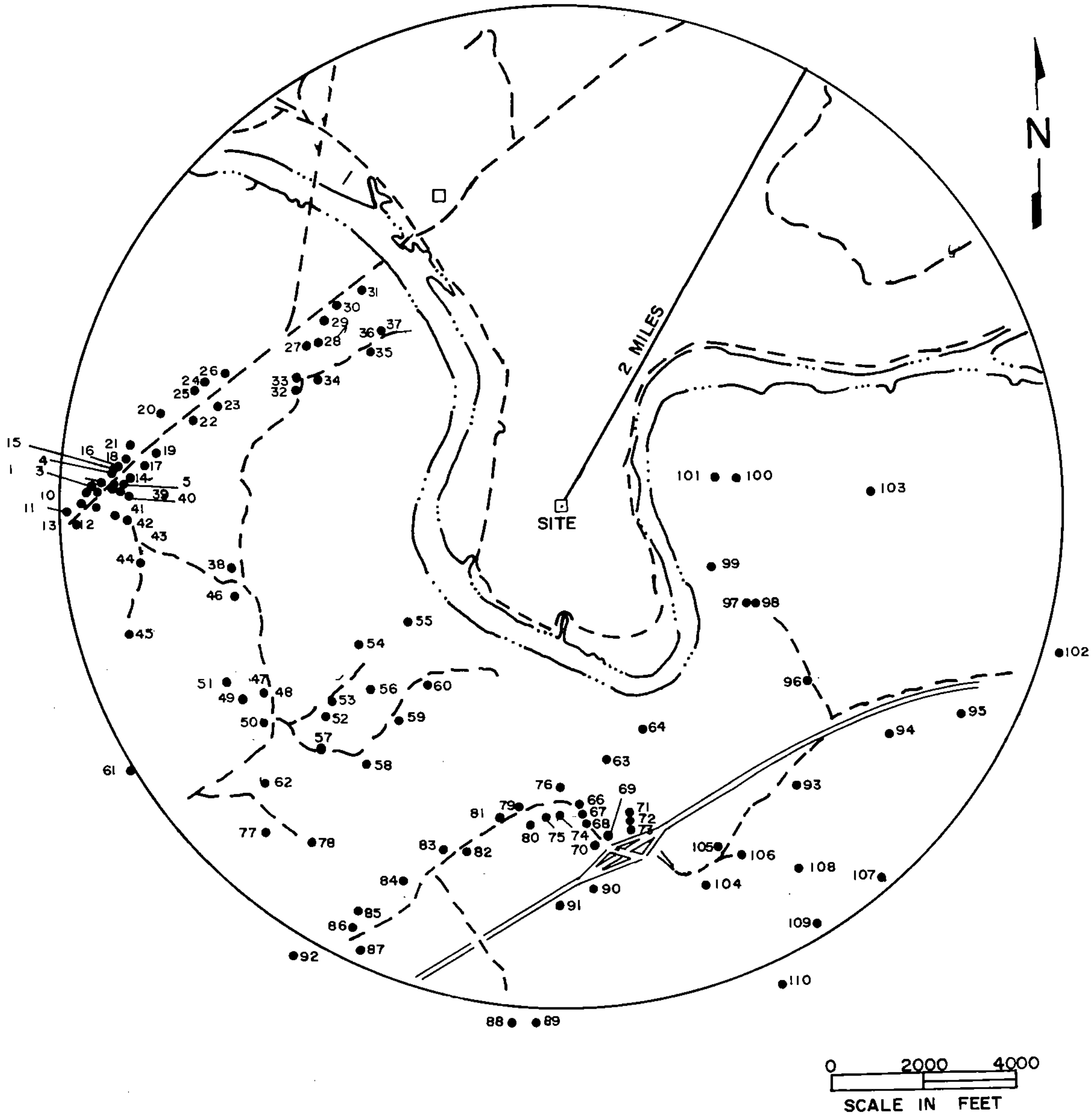
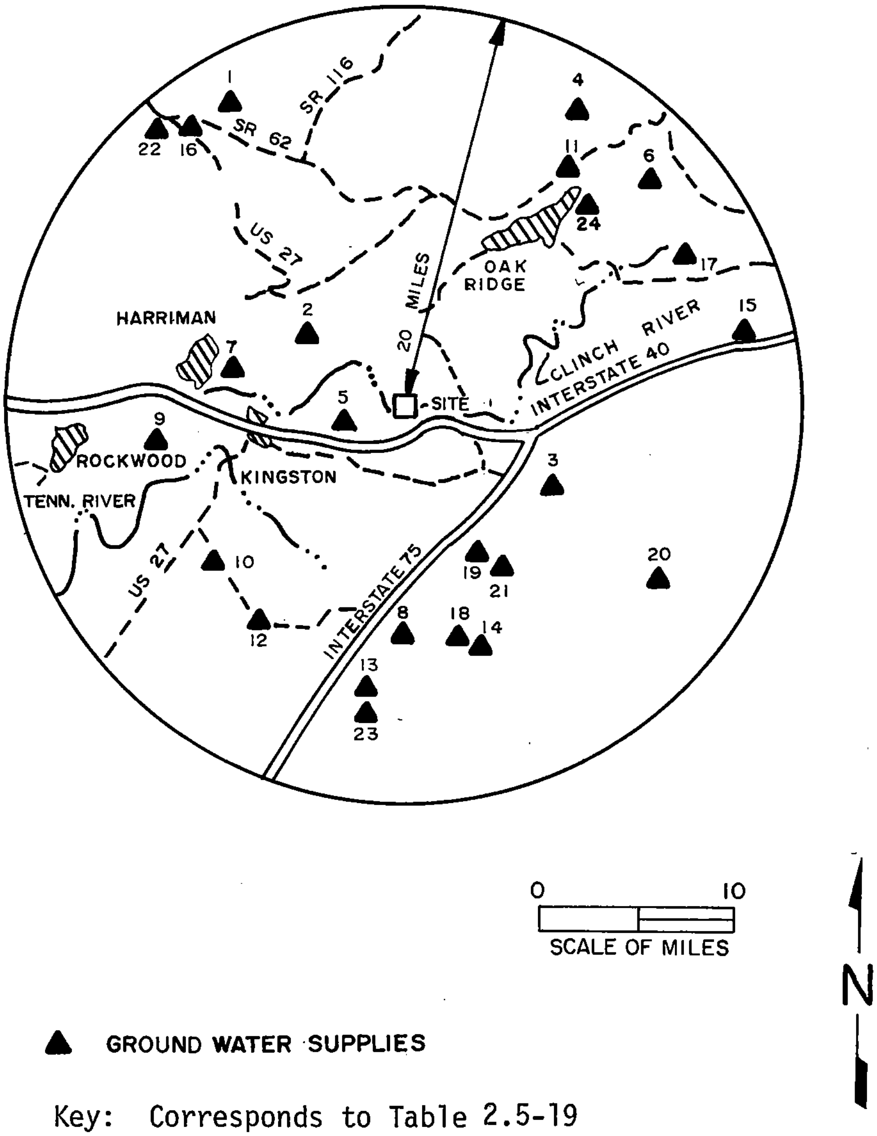


Figure 2.5-11 WASTEWATER DISCHARGES, CLINCH RIVER WATERSHED



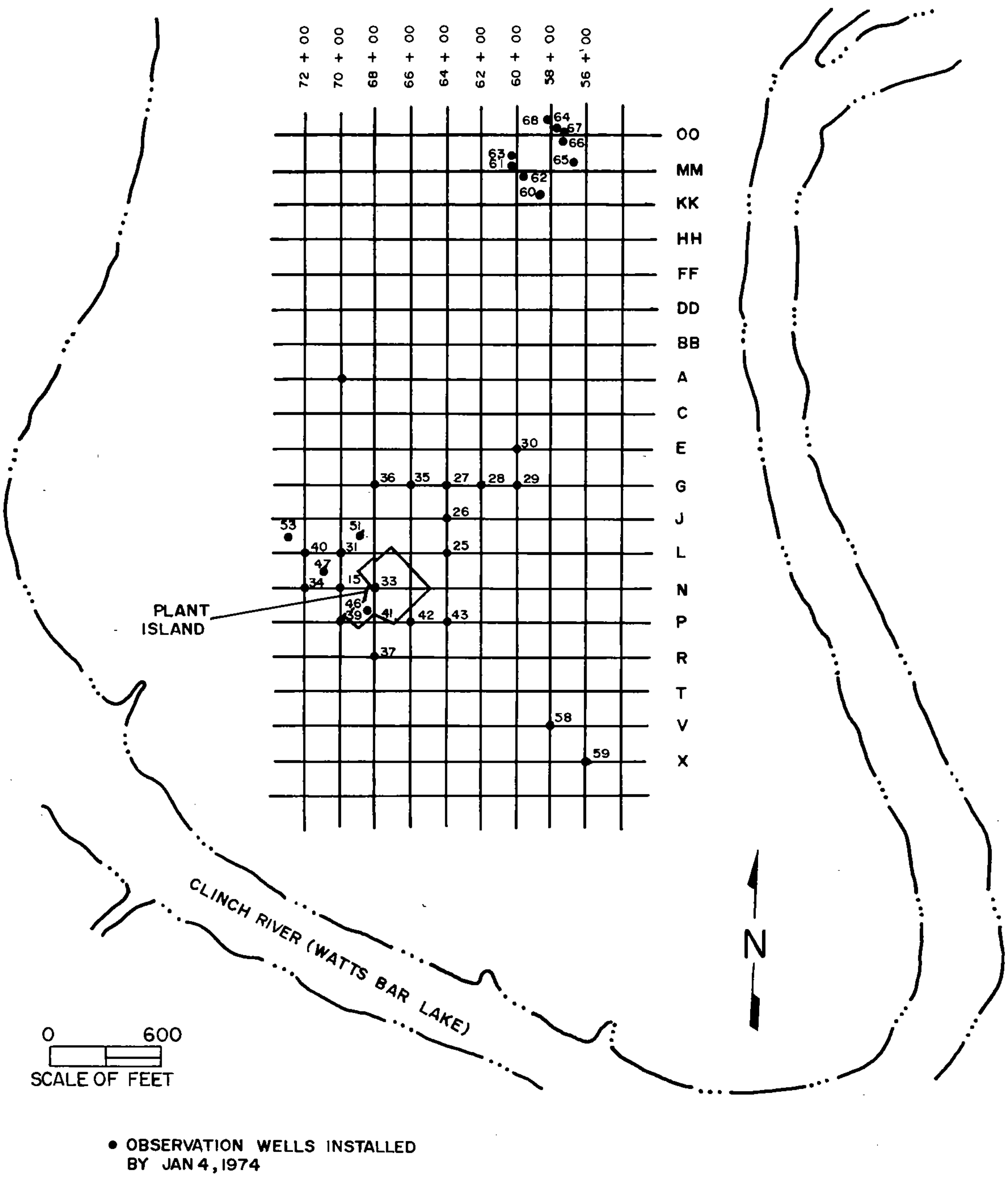
Key: Corresponds to Table 2.5-18

Figure 2.5-12 LOCATIONS OF WELLS AND SPRINGS WITHIN 2-MILE RADIUS OF CRBRP



Key: Corresponds to Table 2.5-19

Figure 2.5-13 LOCATION OF PUBLIC AND INDUSTRIAL GROUNDWATER SUPPLIES



Key: Corresponds to Table 2.5-20

Figure 2.5-14 LOCATION OF OBSERVATION WELLS

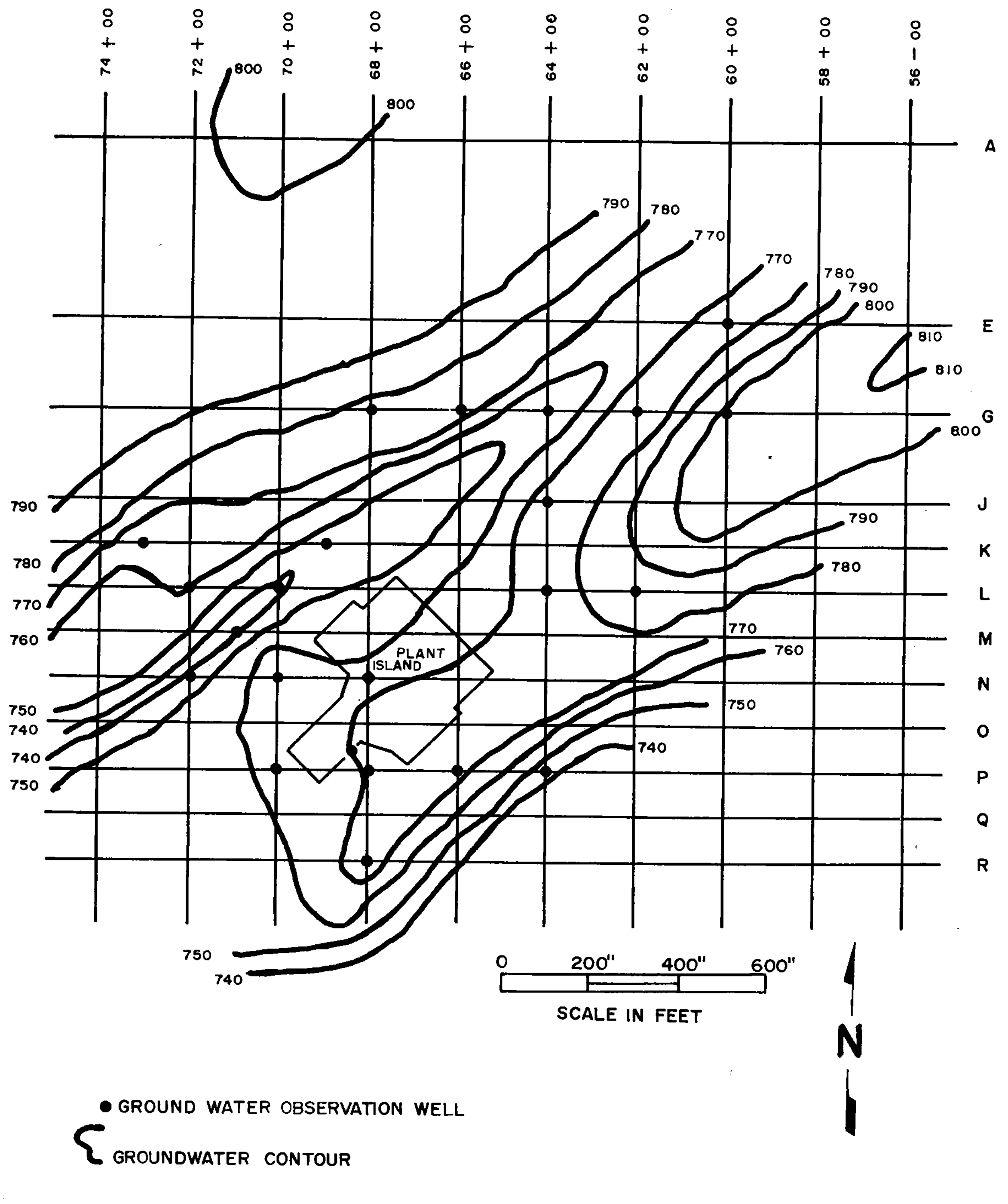


Figure 2.5-15 SITE GROUNDWATER CONTOURS, DECEMBER 24, 1973

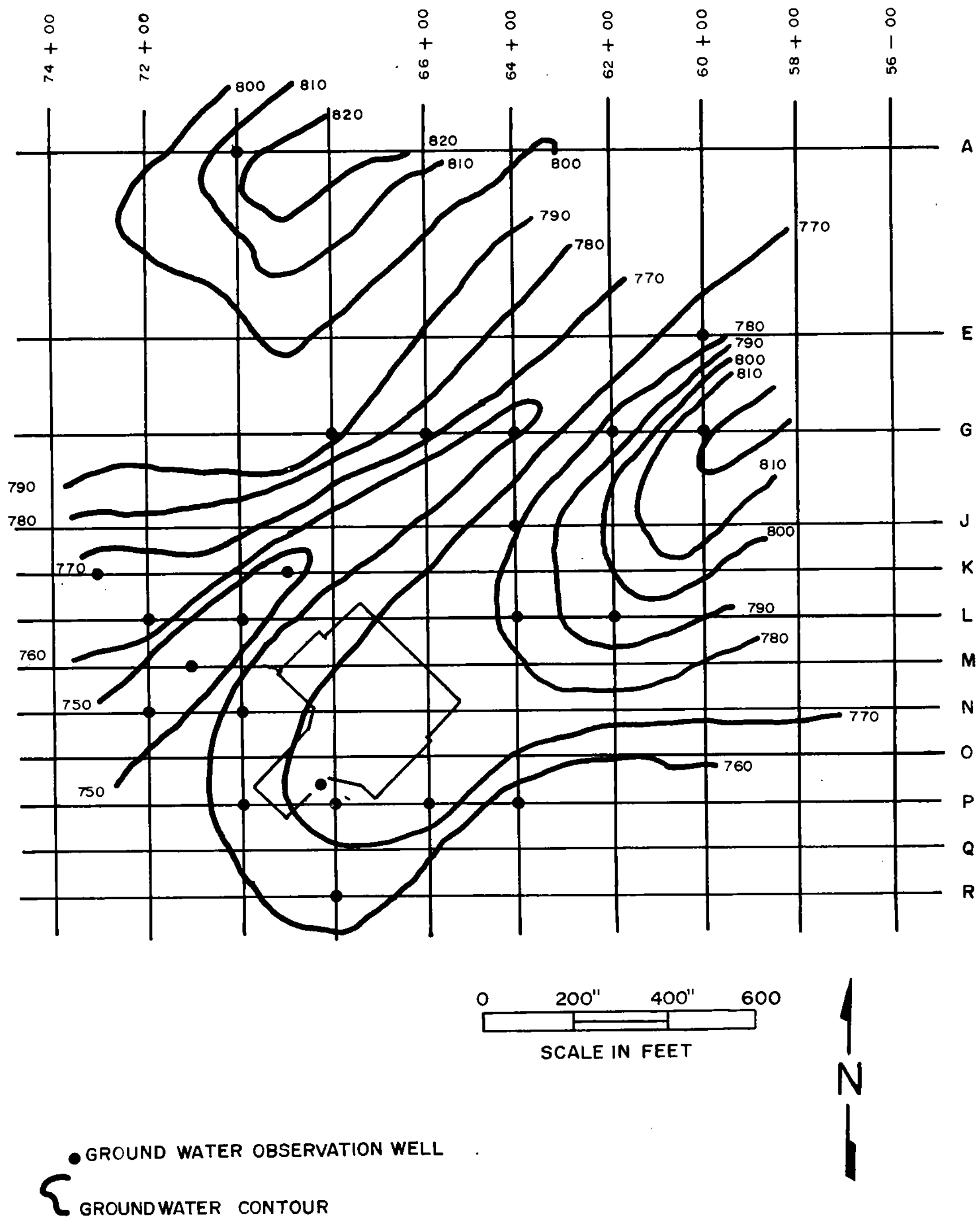


Figure 2.5-16 SITE GROUNDWATER CONTOURS, JANUARY 2, 1974

2.6 METEOROLOGY

2.6.1 REGIONAL CLIMATOLOGY

Meteorological data from the Oak Ridge Area Station X-10,[1,2] located 4.5 miles northeast of the Clinch River Breeder Reactor Plant (CRBRP) Site, were used to characterize the Meteorology/Climatology of the region including the Site. Oak Ridge Area Station X-10 was a first order Weather Bureau Station from 1944 to 1964. (First order Weather Bureau Stations are usually located at major airports and are manned 24 hours a day. These stations record hourly visual observations as well as wind, temperature, dewpoint, etc. Second order stations only record and/or transmit data on physical phenomena.) From 1964 to 1972 only wind, temperature, dewpoint and differential temperature were recorded. The station was discontinued in December 1972. Local climatological data on relative humidity, thunderstorm days and occurrences of heavy fog are available from the Knoxville Airport Weather Station,[3] located about 20 miles east of the Site, and from the Weather Bureau's Oak Ridge City Office,[4] located 10 miles northeast of the Site. Locations of these weather stations are shown in Figure 2.6-1. General information on the climate of the State is available from the U. S. Weather Bureau.[5] Other sources of specialized data are referenced as they appear in this section.

The Site is located in Roane County, Tennessee in a broad valley between the Cumberland Mountains to the northwest and the Great Smoky Mountains to the southeast. Topography of the Site is characterized by subparallel ridges with intervening valleys, as discussed in Section 2.4. Elevations of the ridge crests range between 900 and 1,200 feet.

Topography of the Site is characterized by a series of parallel ridges separated by long, narrow valleys extending in a northeast-southwest direction. The Site lies along a rolling flank of one of these ridges.

Differences in elevation have a measurable influence on the changes in climate along a NE-SW axis; stations at a similar elevation have similar annual mean temperatures and precipitation normals.[5]

Prevailing winds in the region reflect the channeling of air flow caused by the orientation of valleys and ridges of the southern Appalachians; winds are generally northeasterly or southwesterly. Mean annual wind speeds are low compared to other areas of Tennessee and the United States.[6] For example, the mean speed during the 16-year period of record if 4.4 miles per hour at the Oak Ridge City Office. This is the lowest mean annual value for all reporting stations summarized in the Climatic Atlas of the United States.[6]

The region has a mild climate classified Caf by Koppen; it is humid, has a mean temperature for the warmest month of the year in excess of 71.6 degrees F and has no distinct dry season.[7] March is normally the wettest month and October the driest. Precipitation is heaviest from December through March when cyclonic activity is high and in July and August when convective showers occur. Maximum recorded rainfall in a 24-hour period equaled 7.75 inches; this occurred at Oak Ridge Area Station X-10 in September 1944.[1] Temperatures above 90 degrees F occur on a total of 32 to 46 days[5] in an average year. Zero and sub-zero temperatures at the X-10 Station were observed during the months of December, January or February in fewer than half the years from 1945 through 1964. Synoptic (regional) scale weather systems move through eastern Tennessee with irregularity. These storm systems are most frequent during December and January and cause a maximum monthly number of cloudy days and extensive precipitation. Summer season storm systems are usually weaker and tend to pass to the north, leaving eastern Tennessee with sunshine interspersed with thunderstorm activity. Between 50 and 60 thunderstorm days occur per year, with a peak number of storms occurring in July.[5] About nine thunderstorms per month occur during the period of May through August. The region, including the Site, is subject to a small probability of tornado occurrence.

Humidity varies with wind direction, generally being lowest with northeast winds and highest with southeasterly to southwesterly winds. Relative humidity is lowest in the afternoons and highest at night. Average annual humidity in Tennessee is near 70 percent.[6] This is about average for most of the United States east of the 95th meridian. Florida, the Gulf Coast and the Atlantic Seaboard have higher humidities than eastern Tennessee; whereas, the mountains and desert regions of the Western United States have less humidity.

2.6.1.1 MAXIMUM RAINFALL

Maximum recorded point rainfall for the Knoxville Airport for intervals of 5 minutes to 24 hours is listed in Table 2.6-1.[8] Maximum monthly and annual precipitation recorded at the Oak Ridge City Office was 19.27 inches in July 1967 and 76.33 inches in 1973, respectively.[4] Monthly and annual extremes of 14.11 inches in July 1967 and 66.20 inches in 1950, respectively, were recorded at Oak Ridge Area Station X-10.[2] Maximum measured annual rainfall at Knoxville was 61.49 inches in 1957.[3] Calculated rainfall for the Site area for time periods of 0.5, 1, 2, 3, 6, 12 and 24 hours for a recurrence interval of 100 years is given in Table 2.6-2.[9]

2.6.1.2 SEVERE SNOW AND GLAZE STORMS

Winter storms which produce a snowfall in excess of one inch or glaze are uncommon in eastern Tennessee. Snowfalls of one inch or more occur on an average of one day per month in the colder months.[5] The area can expect about three significant snowfalls per year which could be measured at one or more inches.[5] It is unusual to have snow cover for more than a week at a time.[3] Variations recorded over a period of 26 years show that in March 1960, a maximum of 21 inches of snow accumulated with 12 inches falling in a single day. Normal snowfall for March is 1.5 inches.[4] Highest average normal monthly total is 3.2 inches, occurring in January.

Glaze occurred from three to six times per year during a 28-year survey period ending in 1953.[10] Freezing rain can occur during the normally colder months of the year when rain falls through a very shallow layer of cold air from an overlying warm layer. Rain then freezes on contact with the ground or other objects to form glaze. December through early March is the period with the highest frequencies of glaze storms. Based on limited periods of data collection, significant glaze storms producing a glaze ice thickness of 0.25 inch or more on wires occur in eastern Tennessee on an average of one storm every two years.[10] Occurrences for glaze storms applicable to the area including the Site are as follows:[10]

Thickness of 0.25 inch or greater	Once every two years
Thickness of 0.50 inch or greater	Once every five years
Thickness of 0.75 inch or greater	Once every ten years

2.6.1.3 THUNDERSTORMS AND HAIL

Thunderstorms occur on an average of 54 days per year.[4] The month of July usually has the most. An average of about nine thunderstorm days per month occur throughout the season from May through August. As can be seen in Table 2.6-3, the months of October through January have the fewest thunderstorms.

Hail is not too frequent but it does occur with spring thunderstorms which are usually associated with the passage of squall lines or cold fronts. On an index of potential hail damage to residential property, calculated for each area formed by one degree of latitude and one degree of longitude, the Site is in a region of low potential loss due to hail.[11] Maximum values of the index occur in northwest Kansas where the index is 50. The index in eastern Tennessee is about 5. Therefore, on a geographical basis the Site is situated in a region where hail is not a significant factor.

2.6.1.4 TORNADOES

The Site is located in an area infrequently subjected to tornadoes.[12,13] For the purpose of comparison, Tennessee ranked 25th among all states in the number of tornadoes from 1955 to 1967.[14] Dividing along the 86th Meridian, the western half has reported observing three times as many tornadoes as were observed in the eastern half of the State which includes the Site.[13] The Oak Ridge-Clinch River area has one of the lowest probabilities of tornado occurrence in the entire State.[14,15]

Tornado frequencies calculated by Thom[16] for each one-degree square of latitude and longitude for the period 1953 to 1962 show the Site to be situated in a one-degree square with an annual frequency of 0.5. Probability that a tornado will strike any point in a particular one-degree square, such as the site, is calculated as 3.65×10^{-5} per year. Recurrence interval is one over the probability, which is once in 27,400 years. Raw count data on tornado occurrence for those counties near the Site for the period 1916 to 1972 are presented in Figure 2.6-2.[12,17] Roane County is only one of several counties within the one-degree square used for the calculation of the tornado probability. Roane County itself has not recorded a tornado in the 57-year period of 1916 to 1972.

2.6.1.5 STRONG WINDS AND HURRICANES

Thom[18] analyzed data for all first-order weather stations in the U.S. on fastest-mile wind speed at 30 feet above ground level for recurrence intervals as indicated below. Fastest mile is the wind speed in miles per hour based on the shortest recorded time interval in which the wind traveled a horizontal distance of one mile. Instantaneous gusts are thus smoothed out.

A partial record of extreme wind data is available for the Oak Ridge area. The peak gust recorded at the Oak Ridge City Office during a 17-year period was about 59 miles per hour.[4] Fastest mile reported for the Knoxville airport for a 31-year period was 73 miles per hour.[3] A 33-year record at Chattanooga, Tennessee, shows a fastest mile of 82 miles per hour.[19]

CALCULATED FASTEST MILE DATA VS. RECURRENCE INTERVAL[18]
EASTERN TENNESSEE

Recurrence Interval (years)	Fastest Mile (mph)
10	64
25	73
50	76
100	89

Hurricanes are rare as far inland as the Site because hurricanes lose force rapidly when cut off from their source of moisture. Consequently, these storms are in the post hurricane stage with diminished winds by the time they reach the Site area. In the past 70 years the remnants of nine hurricanes, classified as devastating when crossing the coastline of the U. S., have crossed Tennessee.[20] Remnants of the hurricane of August 1940 caused flooding in eastern Tennessee.[20] Visible damage associated with tropical storms occurs about once every 25 years in eastern Tennessee.[5]

2.6.1.6 INVERSIONS AND HIGH AIR POLLUTION POTENTIAL STATISTICS

Hosler[21] and Holzworth[22] have analyzed weather records from many U. S. stations with the objective of characterizing atmospheric dispersion potential.

The seasonal frequencies of inversions based below 500 feet for the region including the Site area, in percent of total hours in a year, are shown in Hosler[21] as follows:

Winter - 42%	Summer - 45%	Annual - 41%
Spring - 32%	Fall - 45%	

Since eastern Tennessee is in a hilly region dominated by anti-cyclonic circulations,[6] inversion frequencies are closely related to the diurnal cycle. Storms during the spring season produce a lesser frequency of nights with long-duration inversion conditions.

Holzworth's data[22] provides an estimate of the average depth of vigorous vertical mixing and provides an indication of the vertical depth of atmosphere available for mixing and dispersion of effluents. For the Site, mean maximum daily mixing depths range from about 1,475 feet in January to 5,250 feet in July. In April and October the mixing depths are about 4,100 and 3,120 feet, respectively. When daytime mixing depths are shallow, pollution potential is highest.

Holzworth[23] has presented statistics for the period 1960 to 1964 on the frequency of combinations of meteorological conditions that give rise to poor dispersion characteristics as indicated by low mixing depths, light winds and no precipitation. An air pollution episode is forecast to occur in urban areas whenever the mixing depth is less than 1,500 m (approximately 5,000 feet), the mean wind speed through the mixing height is less than 4 m/sec (approximately 9 mph), no precipitation is expected to occur and these or worse conditions persist for two days. Figure 2.6-3 is a representation of the total number of forecast-days of high meteorological potential for high air pollution in a five-year period. The Site is in an area where 30 to 35 days of high air pollution potential meteorology occurred in a five-year period. These values average out to six or seven forecast days per year of high air pollution potential meteorology which are high for the eastern United States but low compared to a large area of the western United States.

Other combinations of mixing height and wind speed without precipitation are summarized by Holzworth.[23] The most restrictive combination consists of a mixing height less than 1,640 feet and winds less than 4.5 mph. No episodes satisfying these criteria occurred in the area during the five-year period.

For mixing heights less than 3,280 feet and winds less than 9 mph, there were seven episodes in the five-year period lasting two days or more. Holzworth's data[23] indicate that eastern Tennessee is in a region of unfavorable dispersion with respect to the frequency of occurrence of high air pollution potential meteorology. The greater than normal expectancy of occurrence of high air pollution meteorology is not of great importance to the Site in terms of calculating site boundary doses. It is assumed that: (1) any release of radioactivity would take place at ground level; and (2) the diffusion equation would use the mixing height as a replacement parameter for the vertical dispersion parameter; therefore, limiting the extent in the vertical that dispersion may take place. Since the long-term average dilution factor is largely determined by the frequency of occurrence of very stable atmospheres, replacement of the vertical dispersion parameter from any of Pasquill's stable stability categories for travel distance less than 800 meters with a mixing depth of 1,000 meters or less, is not required because the vertical dispersion in stable air is much smaller than the mixing height.

Analysis of doses resulting from postulated releases are also governed by assumptions that stable air is present. In stable air, mixing height does not play a role in the calculations. Therefore, the effects of high air pollution potential meteorology at the CRBRP Site is not a major concern.

2.6.2 LOCAL METEOROLOGY

Data from the CRBRP Site, the Oak Ridge Area Station X-10, the Oak Ridge City Office and the Knoxville Airport (the closest NOAA weather bureau stations to the Site) have been used as the primary source of local meteorological data,[1,2,3,4] with a few exceptions noted in the following discussion. Climatological statistics of these stations are believed to be representative of the Site area. Supplementary climatological data were obtained from TVA on relative humidities and fog frequencies.[24] Atmospheric dispersion characteristics for the Site have been estimated from diffusion data developed from summaries of hourly data collected at the CRBRP Meteorological Tower during the period July, 1973 through June, 1974 and are continuing to be collected and analyzed as received.

2.6.2.1 TEMPERATURE

Temperature data for the Oak Ridge Area Station X-10 show that a record high temperature of 103 degrees F occurred in July 1952 and in September 1954; a record low temperature of -8 degrees F occurred in January 1963.[1] For comparison purposes the temperature extremes in the Knoxville vicinity were 104 degrees F on July 12, 1930 for the highest and -16 degrees F on January 6, 1884 for the lowest.[3] The annual average daily maximum is 69.4 degrees F and the minimum is 47.6 degrees F, with an average of the monthly mean temperature of 58.5 degrees F. Monthly climatological temperature data for Area Station X-10 and the annual mean temperature data and extremes of temperature for the Oak Ridge City Office and

Knoxville vicinity for comparison purposes are presented in Table 2.6-4. It is apparent by inspection of these data that the three sites are quite similar with respect to temperature except for the extreme low of -16 degrees F recorded in the Knoxville vicinity. This record low is a part of a much longer observation period spanning 100 years and includes more opportunities to observe extremes.

2.6.2.2 WINDS

Wind conditions at the Site are approximated from two sets of available wind data. One set of data is for the Oak Ridge Area Station X-10 and covers the six-year period from 1963 through 1968.[26] A second set of data is from the meteorological tower at the CRBRP Site and covers the one-year period from July 1, 1973 through June 30, 1974. Joint frequencies of wind directions and wind speeds by stability class from the on-site data are contained in Tables 2.6-21 to 2.6-36. The six-year record was to be compared to the shorter record, to establish the long-term representativeness; however, the longer record has an unusually high value for calm wind conditions (23.47%). It is believed that the large frequency of occurrence of calms was because of the wind instrument starting speed of 2 or 3 miles per hour. After modifying the anemometer (1970), the starting speed was reduced to approximately one mile per hour. On that basis the most recent complete year of record for the Oak Ridge Area Station X-10 was processed to generate a diffusion climatology. The results of the most recent one-year record from Oak Ridge Area Station X-10 show a much lower percentage frequency of calm winds (12.1%) but it is still a high value when consideration is given to the fact that the wind sensor is at a height of 102 feet aboveground.[25] The meteorological tower at the CRBRP Site showed the same pattern of occurrence with regard to the calm winds. The percentage frequency of calm winds (12.4%) at an elevation of 75 feet aboveground were about the same as the Oak Ridge Area Station X-10; however, data obtained from the on-site meteorological tower at 200 feet aboveground show that the percentage frequency of calm winds is only 0.9%. Even though the record length is shorter, the one-year summary of data from the CRBRP Meteorological Tower is considered more valuable because of the more accurate representation of the CRBRP Site.

A one-year summary of winds for the CRBRP Meteorological Tower shows that the prevailing wind at the 75-foot level is from the southwest with an average speed of 4.9 miles per hour on an annual basis. For the same location, but at the 200-foot level, the prevailing wind is from the southwest with an average speed of 6.7 miles per hour on an annual basis. Knoxville Airport data show that the prevailing wind is from the northeast with a mean hourly speed of 7.4 miles per hour which is not consistent with the CRBRP Site data. The Oak Ridge City Office shows a prevailing wind from the southwest with a mean speed of 4.4 miles per hour which is consistent with the CRBRP Meteorological Tower data. These data serve to emphasize the importance of terrain on channeling the wind flow in hilly areas. A summary of these data is provided in Table 2.6-5.

2.6.2.3 HUMIDITY

A 13-year record of relative humidity by months is available for four selected observation times during the day for Knoxville Airport. A four-year record of relative humidity and temperature data from the Bull Run Steam Plant were used to generate frequency distribution of relative humidity according to ambient temperature. The Bull Run data is more representative of the CRBRP Site than the Knoxville data since the Bull Run sensor is located in a river valley similar to the Site. The river valley will affect wind flow and provide a mositure source that is reflected in the relative humidity data. Regardless of the location, the relative humidity varies inversely with temperature if the water content of the air is constant. Relative humidity is lowest at the time of maximum temperature and highest at the time of minimum temperature. Low relative humidities are expected to occur in mid-afternoon near the time of maximum temperature and high relative humidities are expected to occur in early morning at the time of minimum temperature. Monthly average relative humidity data for the Knoxville Airport are summarized in Table 2.6-6.[3] The summary of the five-year Bull Run data is in Table 2.6-7.

2.6.2.4 PRECIPITATION

Average annual precipitation is 51.52 inches at the Oak Ridge Area Station X-10 based upon 21 years of record.[1] Winter is the wettest season when 31 percent of the annual precipitation is recorded. February and March are the wettest months when about 5.4 inches of precipitation is normal. October is the driest month with a normal average of only 2.82 inches. Maximum monthly rainfall occurred in September (12.84 inches) and the maximum observed in a 24-hour period was 7.75 inches which also occurred in the month of September at Oak Ridge Area Station X-10, as shown in Table 2.6-8.[1]

Snow and ice pellet data for the Oak Ridge City Office are summarized in Table 2.6-9.[4] Data listed in the table show that the annual snowfall averages about 10 inches. Maximum snowfall in the 26-year period was 41.4 inches, more than four times the annual mean. Heavy snows, when more than six inches are recorded in 24 hours, have occurred in each month from November through March.[4]

2.6.2.5 FOG

Incidence of heavy fog (1/4 mile or less visibility) varies greatly around Tennessee.[5] Typical values include 31 days at Knoxville,[3] 34 days at Oak Ridge City Office[4] and 36 days at Chattanooga.[19] Five months of the year have an average fog frequency of three days or more at all three stations. At Oak Ridge, October has the highest fog incidence with an average of eight occurrences. Monthly mean number of heavy fog days for Knoxville and Oak Ridge are shown in Table 2.6-10. Supplementary fog data recorded at two sites along the Melton Hill Lake, upstream from the CRBRP Site and shown in Table 2.6-11, show that fogs which restrict the visibility to 1,100 yards or less are very common for observation points near the river or lake.[24] The data reported here are not completely comparable to that recorded at Knoxville or the Oak Ridge City Office because of the difference in definitions, but it does serve to point out that fogs are very common in the region, including the Site. Fogs which restrict the visibility to 1,100 yards or less were observed, on the average, 90.52 days per year at the Bull Run Creek site (about 15 miles northeast of the CRBRP Site) and 119.47 days per year at the Melton Hill Dam Site (about 4.5 miles east of the CRBRP Site) for the period January 1964 to October 1970.

Fog which restricted visibility to less than 550 yards was recorded at the Melton Hill Dam Site on an average of 106.01 days per year.[24] This value is about three times that recorded at Oak Ridge.

2.6.2.6 WIND AND STABILITY DATA

Source of the information for developing a diffusion climatology to represent the Site is a one-year record of wind and temperature difference measurement made on a 200-foot tower at the cRBRP Site. The year of record covers the period July 1973 through June 1974. Data recovery for the period is 88.3 percent for the 75-foot level and 87.1 percent for the 200-foot level. For the purpose of comparison, a one-year record of wind data from the Oak Ridge Area Station X-10 is presented in Tables 2.6-12 through 2.6-19. The X-10 data has a recovery rate of 99.6 percent.

The method of sorting the observations into the Pasquill stability classes is based on the temperature gradient scheme of AEC Regulatory Guide 1.23 which is predicated on temperature difference measurements made between sensors separated by at least 100 feet of vertical height and with the lowest sensor about 10 meters (33 feet) aboveground. At the CRBRP installation the lowest temperature difference sensor is located at a height of 75 feet aboveground. To insure that the location of the temperature sensor at a height of 75 feet aboveground does not affect the determination of atmospheric stability, another temperature sensor was installed on April 3, 1974 at a height of 33 feet aboveground. Joint frequency distributions of wind speed and direction by stability classes were made for the temperature difference between 200 feet and 75 feet and for the temperature difference between 200 feet and 33 feet for the same corresponding time intervals. The data results in Table 2.6-20 show that for the stable conditions (Pasquill Stability Classes G, F and E) the frequency of occurrence is approximately equal. The variations in frequency occur in the neutral (Pasquill Stability Class D) and the unstable (Pasquill Stability Classes A, B and C) conditions. By locating the temperature sensor closer to the ground, the affect is to reduce the frequency of unstable conditions and enhance the neutral conditions. Since an examination of χ/Q values shows that for the downwind distance of the minimum exclusion distance and for a common wind speed, one hour of stability type G is worth: 2.4 hours of stability type F, 7.0 hours of stability type E, 24 hours of stability type D, 80 hours of stability type C. It is apparent that type G carries maximum weight in dose calculations. Annual wind records are summarized in Tables 2.6-21 through 2.6-28 for the 75-foot level aboveground and in Tables 2.6-29 through 2.6-36 for the 200-foot level aboveground. These tables present the joint percentage frequency distribution of wind speed and direction for the seven Pasquill stability categories, A through G, and for all observations. Annual and seasonal wind roses are shown for the 75-foot level in Figures 2.6-4 through 2.6-8 and for the 200-foot level in Figures 2.6-9 through 2.6-13.

Annual, winter, spring, summer and fall wind roses for the 75-foot level clearly show the tendency for the channeling of the wind to align with the northeast to southwest orientation of the valleys and the influence of the river curling around the southern boundary of the Site. Most frequent wind directions for these wind roses are southwest as the predominate direction and east as the second most predominate direction. The winter season wind roses, for both levels, show the influence of winter storms and passage of cold frontal systems upon the wind flow by shifting the predominate wind direction to the northwest sector. The summer and fall wind roses reflect wind conditions with high frequency of occurrence for light or calm winds which are consistent with a persistent high pressure system situated over or to the north of the Site. Pressure patterns published in the Climatic Atlas of the United States[6] support this conclusion.

Highest wind direction frequency observed for the 75-foot level is from the south-southwest. Winds are from the southwest plus or minus one 22.5 degree sector 30.79 percent of the time and from the east-northeast, plus and minus one 22.5 degree sector 21.73 percent of the time on an annual basis. The percentage of south-southwest to west-southwest winds increases slightly during the spring months. During the fall season the percentage of winds from the east-northeast plus and minus one 22.5 degree sector, increases to 27.07 percent while the percentage of winds from the southwest plus and minus one 22.5 degree sector decreases to 25.44 percent.

Modal wind speed group is 4 to 6 mph for all seasons of the year and for all wind directions as can be seen in Figures 2.6-4 through 2.6-8. Calms vary on a seasonal basis from a low of 9.06 percent during the winter season to a high of 13.92 percent during the summer season for the 75-foot wind level. The annual percent occurrence of calm is 12.40 percent.

Distribution of the seven Pasquill stability categories on a monthly basis are summarized in Table 2.6-37 for the 75-foot wind level and in Table 2.6-38 for the 200-foot wind level. Adverse dispersion categories are stability classes F and G, as these two classes contribute about 85 percent of the weight in the calculation of atmospheric dilution factors. At the 75-foot wind level, Type G stability is a minimum during the months of July, August and September, averaging about five percent. Type G is a maximum in the month of April, with a frequency of occurrence of about 29 percent, however, the data recovery rate was not acceptable, leading to the possibility that the high frequency of occurrence of Type G Stability may not be representative of the long term record for the month of April.

Type F stability is maximum in the months of August and September, occurring about 25 percent of all hours in each month which is contrary to the pattern for type G which was a relative minimum at this time of year. At the other end of the atmospheric stability spectrum type A stability occurs most frequently in the months of July, August and September with monthly frequencies gerater than 26 percent. January and February show the fewest occurrences for type A stability.

On an annual basis, Pasquill's type D (neutral stability) class is most common. Type D stability is a maximum in the month of January when it occurs with a frequency of about 53 percent. Small frequencies of occurrence of stability types B and C are largely a product of the classification scheme used to define the range of temperature differential values that define these classes. The "target" is only 0.2 degrees C per 100 meters wide for types B and C and most observations fall outside of this range.

2.6.3 POTENTIAL INFLUENCE OF THE PLANT AND ITS FACILITIES ON LOCAL METEOROLOGY

Some influence on local meteorology will be exerted by the plant itself.

Because the plant area will be cleared of trees, leveled, bladed, graded and black topped, it will change the albedo (reflective power) of the earth in this area and produce a small local heat island which would be discernable with a proper set of measuring and sensing systems. The effect on temperature would be similar to that found by Norwine,[28] which was two degrees F for a shopping center.

The shape of the buildings erected on the plant site will create aerodynamically disturbed air flow which in turn will alter the distribution pattern and diffusion rates of windborne contaminants on the leeward side of the buildings. This effect is discussed in Section 2.6.6.1.1.

It is planned to dissipate waste heat carried by recirculated cooling water in cooling towers. Evaporation of water into the atmosphere will form a visible vapor plume if the atmosphere is either very humid, or very cold and moderately humid. The vapor plume will alter, to a small degree, the amount of sunshine received in the small areas most frequently in the shadow formed by the plume. On rare occasions small cumulus clouds could form above or remote from the tower, depending on atmospheric temperature and water vapor conditions in the first few thousand feet above the cooling tower. The plume may diffuse to ground level and form fog and in freezing temperatures cause rime ice on vertical structures and road systems. These environmental impacts are discussed in Section 5.1.

2.6.4 TOPOGRAPHICAL DESCRIPTION

The Site is on a peninsula approximately between river miles 15 and 18 on the Clinch River. This region is characterized by a series of parallel ridges extending in a northeast-southwest direction. The Site lies along a rolling flank of one of these ridges which slopes gradually toward the Clinch River. Normal reservoir pool elevation is 741 feet. Mean elevation of the Site is 862 feet.

Figures 2.6-14 and 2.6-15 are topographic maps showing the area surrounding the Site. Topographic profile cross sections in each of the eight cardinal compass directions radiating from the Site are shown in Figure 2.6-16. A topographical profile cross section indicating the meteorological tower location, sensor heights and center of containment building with respect to the current topography is given in Figure 2.6-17. Terrain to the south of the Site, approximately 3,700 feet beyond Watts Bar Lake, rises abruptly to a height of about 240 feet above plant grade which is 815 feet. This obstacle to air flow will influence the dispersion rate at this distance. The expected effect is discussed below. Hills or ridges of similar height are found within two miles of the Site in practically every direction except towards the northwest.

The highest point within a radius of five miles of the Site is Melton Hill, elevation 1,356 feet, about 4.75 miles fo the east-northeast of the plant. Lowest points within a radius of five miles of the Site are along the margins of Watts Bar Lake, the surface of which averages 738 feet MSL.

It is anticipated that the irregular terrain will have a significant effect on dispersion rates in special meteorological situations. In stable air with light winds, pockets of stagnation may develop at the base of sharply rising hills or bluffs which could cause short-term increases in air concentration levels. These concentration levels can only subjectively be estimated to amount to perhaps a factor of four over normal if the stagnation lasts 18 hours or more. The factor of four increase is based on the behavior of the county-wide air pollution index in Pittsburgh, Pennsylvania, between good dispersion conditions and stagnation dispersion conditions. In stagnation periods, the index increases from 25 to about 100. (Pittsburgh provides a convenient reference index because it is located in a similar topographical setting, with steep hills and river valleys.) These conclusions may not apply to a single isolated source as wind direction variability would tend to spread effluents over all sectors.

Slopes which face the southeast through southwest directions present a surface which is more nearly normal to the incidence of solar radiation. This effect will enhance and improve dispersion rates for any air contaminants approaching the slope due to the production of thermally induced vertical air motions. No credit for this effect is considered in the calculations of atmospheric dilution factors.

Modifications of the air mass due to travel over water is not considered to be significant as the over-water fetch is limited and the temperature contrast between air and water does not reach the extreme values required for rapid air mass modification.

It is difficult to generalize on the overall effect of terrain on the long-term average dilution factor. Normally, irregular terrain will promote mechanical turbulence and enhance the dispersion of effluents. But, average wind speeds in the area are low and during the fall season periods of stagnation are fairly common. It is believed that the net effect of the irregular terrain could be demonstrated to improve dispersion rates near the Site as observed in the Mountain Iron Diffusion Trials.[29] In these trials of diffusion over rugged terrain, valley location sampling points were lower in concentration than ridge lines by about 50 percent.[29]

2.6.5 ON-SITE METEOROLOGICAL MONITORING PROGRAM

An on-site measuring program was initiated on April 11, 1973. A hygrothermograph was added in May 1973, and a direct delta-T system was installed on the tower in April 1974. The site for the meteorological installation is considered temporary as it may have to be relocated after one or two years of data are collected to accommodate final plant layout, construction activities, etc. Monitoring program details can be found in Sections 6.1.3 and 6.2.4.

Wind instrumentation on the tower consists of Climet Instruments, Inc., Model 011-1 for wind speed and Model 012-11 for wind direction. Starting speed for the wind speed sensor is 0.6 miles per hour. Operating range is 0-90 miles per hour. Accuracy is within one percent of true value or 0.15 miles per hour, whichever is greater. The direction sensor operates through a range of 0-540 degrees with an accuracy of $\pm$ 3 degrees. Damping ratio is 0.4.

Ambient temperature sensors on the tower are Aerodet (ARI Industries, Inc.), Model R-22.3-3E100, platinum resistance thermometers mounted in motor aspirated radiation temperature shields, Climet Instruments, Inc., Model 016-1. Calibration range is 0-100 degrees F with output from -20 degrees F to 120 degrees F. The accuracy is $\pm$ 0.6 degrees F which includes a maximum radiation error of 0.2 degrees F.

The direct delta-T system measures the temperature difference between 75 and 200 feet. The measuring bridge consists of two dual opposing platinum resistance thermometers, Aerodet (ARI Industries, Inc.) Model R-22.3-3E100, mounted in individual motor-aspirated temperature shields, Climet Model 016-1. The delta-T range is -40 to +40 degrees F. In the range of greatest interest, -5.0 to +5.0 degrees F, the field-tested normal accuracy is $\pm$ 0.13 degrees F, and the probable maximum error is $\pm$ 0.24 degrees F.

The hygrothermograph (4 feet aboveground, in a Stevenson Screen) is a Belfort Instrument Co. Model 5-594, ambient temperature chart range -30 to +110 degrees F and relative humidity range 0 to 100%. The maximum possible relative humidity error is $\pm$ 4%. The reading accuracy of temperature is to the nearest whole degree. The data is recorded on analog strip-charts and must be reduced manually.

Output of the wind sensors is divided and sent through Westinghouse signal conditioning devices before recording on Westinghouse Pulse-O-Matic magnetic tape recorders and on 0 - 1 ma Esterline Angus two-channel recorders which provide analog backup. Output from the temperature sensors is handled similarly except that the analog backup is on a two-channel Texas Instruments multirange recorder set at 0-10 MV. All chart speeds are two inches per hour. Outputs from the sensors are stored on Westinghouse Pulse-O-Matic cassette tape recorders. The site is inspected weekly by an electrical engineer or an instrument technician to ensure that all instruments are in good working order. It was planned to check the calibration accuracy of the various instruments and Pulse-O-Matic system every six months. Beginning in early 1974, the electronic calibration frequency was increased to about once a month. The sensors are changed out about once every six months. Input is integrated continuously for 15-minute intervals, then averaged. The 15-minute data are further averaged to provide average hourly values for the several variables. These values are printed out chronologically by hours for each month and the data screened for accuracy.

Pasquill stability categories are determined according to preestablished ranges of the temperature difference as suggested by AEC Regulatory Guide 1.23. Data processing of wind speed direction by the seven Pasquill stability categories are calculated on a seasonal and annual basis.

2.6.6 SHORT-TERM (ACCIDENT) DIFFUSION ESTIMATES

A statistical analysis of relative dilution factors (χ/Q) calculated from hourly data for the CRBRP Meteorological Station diffusion climatology was performed to define the 95 percent and 50 percent χ/Q values. The 95 percent value represents a level of dilution in the atmosphere which is very poor and occurs only about five percent of the time. Dilution will be better than that specified by the 95 percent value 95 percent of the time. Dilution will be poorer (less dilution) five percent of the time. Thus, the approach is conservative in nature. The 50 percent value is the median value of dilution for the summarized data and hence, a more realistic estimate. Fifty percent values are used to assess the consequences of postulated plant releases evaluated in the Environmental Report. The 95 percent value was found to occur in Pasquill stability G, wind speed 0.6 mph (0.28 m/s), while the 50 percent value occurred in Pasquill stability class D, wind speed about 2.5 mph (1.1 m/s). These values are listed as a function of distance in Table 2.6-39.

Estimates of atmospheric dilution factors (χ/Q) representative of post-release time periods up to 30 days are presented in Table 2.6-40 for downwind distances as far as 20 miles from the reactor plant including the minimum exclusion distance (2,200 feet).

2.6.6.1 CALCULATIONS

Atmospheric dilution factors (χ/Q) applicable to discrete time intervals up to 30 days following postulated releases were estimated for downwind distances from the minimum exclusion distance to 20 miles from the reactor plant. The time intervals selected for this analysis were the same four periods specified in AEC Regulatory Guide No. 1.4; 0 to 8 hours, 8 to 24 hours, 1 to 4 days and 4 to 30 days. Data obtained from the meteorological tower at the CRBRP Site were utilized to define climatological parameters representing conservative (pessimistic) dispersion conditions based on measured persistence data consisting of wind direction and atmospheric stability.

Persistence of stability and wind direction frequency for the period July 1973 through June 1974 were selected for this purpose since that particular period of record provided the latest available data with the highest percentage of data recovery (88.3%) for the 75-foot wind level. The specific data used to develop these estimates of short-term diffusion for the Site are presented in Table 2.6-41. Wind speed used in these analyses was the median wind speed for each stability class at the 75-foot level for the period of July 1, 1973 through June 30, 1974.

Calculation of atmospheric dilution factors was performed using the Gaussian diffusion equation for ground level concentration from a continuously emitting source released at ground level:[30]

$$\chi/Q = \frac{1}{\pi \bar{u} \sigma_y \sigma_z} \exp\left[-1/2 \quad y^2/\sigma_y{}^2\right] \qquad (1)$$

where,

χ = Activity concentration, Curies/m^3

Q = Activity release rate, Curies/sec

$\bar{u}$ = Mean wind speed, meters/sec

y = Crosswind distance, meters

σ_y = Crosswind dispersion parameter, meters

σ_z = Vertical dispersion parameter, meters.

The dispersion parameters σ_y and σ_z were evaluated in accordance with the Pasquill-Gifford curves[30] except for stability class G which was obtained from AEC Licensing Staff, Site Analysis Branch, Directorate of Licensing.[31]

Atmospheric dispersion models and assumptions employed for each of the post-release time intervals are described in more detail below.

2.6.6.1.1 TIME INTERVAL: 0 TO 8 HOURS

A review of the on-site, one-year climatological record revealed that extremely stable diffusion conditions have not persisted for time intervals exceeding eight hours. A maximum persistence of four hours is shown in Table 2.6-42. Therefore, atmospheric dispersion during the first four hours following postulated releases was assumed to proceed under extremely stable (Pasquill Type G) diffusion conditions and during the second four hours it was assumed to proceed under very stable (Pasquill Type F) diffusion conditions. It was further assumed that the wind was steady (constant direction) over the entire period.

Atmospheric dilution factors for this time interval consisted of centerline concentrations from a ground level release based on the Gaussian diffusion equation:

$$\chi/Q = \frac{1}{\pi \bar{u} \Sigma_y \Sigma_z} \tag{2}$$

Effect of turbulent wake on the distribution of airborne activity in the vicinity of the reactor building was taken into account by making the following corrections to the dispersion parameters:

$$\begin{aligned} \Sigma_y &= (\sigma_y^2 + CA/\pi)^{1/2} \\ \Sigma_z &= (\sigma_z^2 + CA/\pi)^{1/2} \end{aligned} \tag{3}$$

substituting for Σ_y and Σ_z from equation (3),

$$\frac{\chi}{Q} = \frac{1}{\pi \bar{u} \sigma_y \sigma_z} \cdot W \tag{4}$$

where $$W = 1 \Big/ \left[1 + \frac{CA}{\pi}\left(\frac{1}{\sigma_y^2} + \frac{1}{\sigma_z^2}\right) + \left(\frac{CA}{\pi}\right)^2 \frac{1}{\sigma_y^2 \sigma_z^2}\right]^{1/2}$$

is a reduction factor due to the effect of turbulent wake in the vicinity of the reactor building.

C = 0.5 and A is the minimum cross-sectional area of the reactor building in accordance with AEC Regulatory Guide 1.4. The area of the reactor containment (2,415 square meters) was used for this purpose. A maximum reduction factor of three, in accordance with AEC Regulatory Guide 1.4, was used to correct the χ/Q value although the wake correction model did yield higher values at close-in distances.

Actual reduction factors applied to the χ/Q values estimated for the turbulent effect of the building for the 95 percent, 50 percent and the 0 to 8 hour interval are listed in Table 2.6-42.

2.6.6.1.2 TIME INTERVAL: 8 TO 24 HOURS

Stability conditions determining atmospheric dispersion during this time interval were also derived from the stability persistence data shown in Table 2.6-41. In this instance, the portion of the maximum persistence for the Extremely Stable diffusion class (4 hours) and for the very stable diffusion class (4 hours) has been accounted for in the prior 0 to 8 hours time interval. For this time interval (16 hours) it was assumed that diffusion conditions shifted to the slightly stable Type E category, the next most stable class in the Pasquill-Gifford stability classification scheme for seven (7) of the sixteen (16) hours. It was further assumed that diffusion conditions shifted to the neutral type D category for the remaining nine (9) hours of this time interval.

It was further postulated that the wind remained in a single 22.5 degree sector but meandered uniformly over this sector. The time-averaged atmospheric dilution factor for a wind that meanders uniformly within a single 22.5 degree sector for a mixture of stability and wind speed conditions was calculated from the equation:

$$\frac{\chi}{Q} = \left(\frac{2}{\pi}\right)^{1/2} \sum_{s} \sum_{j} \frac{F\ (\Theta,s,j)}{\sigma_{zs}\ \bar{u}_j \left(\frac{2\pi x}{16}\right)} \qquad (5)$$

where,

χ = Activity concentration, Curies/m^3

Q = Activity release rate, Curies/sec

$F(\Theta,s,j)$ = The frequency during the period of interest that the wind is from the direction Θ, for the stability condition s and wind speed class j

σ_{zs} = The vertical dispersion parameter evaluated at the distance x for the stability condition s, meters

$\bar{u}_j$ = The representative wind speed for class j, meters/sec

x = Distance downwind, meters.

2.6.6.1.3 TIME INTERVAL: 1 TO 4 DAYS

A sufficient time lapse occurs during this interval that a recurrence of the prolonged stability conditions which were assumed to have taken place in the two earlier time periods is considered to be feasible. It was, therefore, postulated that diffusion conditions in the 1 to 4 day interval following a postulated release would comprise Extremely Stable (Pasquill G), Very Stable (Pasquill F), Moderately Stable (Pasquill E) and Neutral (Pasquill D) conditions with the same relative distribution as the maximum hourly persistence data of the CRBRP July 1973 through June 1974 historical record. As shown in Table 2.6-41, the sum of the hours of maximum persistence for these four stability categories is 26 hours.

Accordingly, it was assumed that the frequency of the Extremely Stable condition (which lasted a maximum of four hours) during this time interval would be 15.4 percent (4/26). Corresponding frequencies used for the Very Stable, Moderately Stable and Neutral conditions were 15.4 percent, 26.9 percent and 42.3 percent, respectively.

On the basis that the maximum hourly persistence of wind from any direction was 11 hours and that the maximum frequency on a monthly basis was approximately 13.6 percent (4.1 days equivalent), a wind direction frequency of 50 percent (1.5 days equivalent) was assumed for this time interval.

The calculation of atmospheric dilution factors was accomplished with the same basic expression used for obtaining the time-averaged factor in the 8 to 24 hour time interval.

2.6.6.1.4 TIME INTERVAL: 4 TO 30 DAYS

The distribution of atmospheric stability and wind direction frequencies for this extended time interval was derived from monthly frequency data. As shown in Table 2.6-41, the maximum frequency of wind in a single sector over the period was approximately 13.6 percent. Distribution of atmospheric stability conditions used for this time period was based on the CRBRP record of July 1973 through June 1974, 75-foot wind level. The time-averaged expression for ground level concentration was also used to obtain estimated values of atmospheric dilution factors.

A summary of the assumptions used in estimating χ/Q values for each of the four time intervals is presented in Table 2.6-43.

2.6.7 LONG-TERM (ROUTINE) DIFFUSION ESTIMATES

Estimates of atmospheric dilution factors (χ/Q) for downwind distances up to 50 miles in 16 compass directions are provided in Tables 2.6-44, through 2.6-48 for the 75-foot wind level and in Tables 2.6-49 through 2.6-53 for the 200-foot wind level for long-term releases (seasonal and annual). For the 75-foot level, the south sector experienced the lowest ground level concentration for the spring and summer seasons, with the southeast sector lowest in the fall and the north-northwest sector lowest in winter. Sectors with the highest concentrations are northeast in the spring, summer and winter, and west in the fall. Summer season is the season of poorest diffusion characteristics. On an annual basis using the 75-foot level, the highest χ/Q value occurs in the northeast sector.

2.6.7.1 CALCULATIONS

Annual and seasonal χ/Q values were calculated from the equation:

$$\frac{\chi}{Q} = \left(\frac{2}{\pi}\right)^{1/2} \sum_{s} \sum_{j} \frac{F(\Theta,s,j)}{\sigma_{zs}\, \bar{u}_j \left(\frac{2\pi x}{16}\right)} \tag{6}$$

where,

χ = Activity concentration, Curies/m^3

Q = Activity release rate, Curies/sec

$F(\Theta,s,j)$ = The frequency during the period of interest that the wind is from the direction Θ, for the stability condition s and wind speed class j

σ_{zs} = The vertical dispersion parameter evaluated at the distance x for the stability condition s, meters

$\bar{u}_j$ = The representative wind speed for class j, meters/sec

x = Distance downwind, meters.

The equation was summed over all wind speed and stability classes with σ_z taking appropriate values according to the Pasquill-Gifford Classification scheme except for Type G diffusion values for σ_z, which were obtained from AEC Licensing Staff, Site Analysis Branch, Directorate of Licensing.[32] Meteorological data used to calculate these χ/Q estimates were obtained from seasonal statistical summaries prepared by WESD from the hourly data for the CRBRP meteorological system for the period July 1973 through June 1974. Data recovery for this period of record was 88.3 percent utilizing the 75-foot level winds and 87.1 percent utilizing the 200-foot level winds.

TABLE 2.6-1

MAXIMUM RECORDED POINT RAINFALL[8]
KNOXVILLE, TENNESSEE AIRPORT
(1899-1961)

Rainfall in Indicated Periods (inches)

Minutes					Hours				
5	10	15	30	60	2	3	6	12	24
0.58	0.99	1.37	2.57	3.52	3.57	3.97	4.88	5.60	6.20

Maximum monthly: 11.74

Maximum annual: 61.49

TABLE 2.6-2

CALCULATED MAXIMUM RAINFALL OVER VARIOUS TIME PERIODS[9]
FOR A RECURRENCE INTERVAL OF 100 YEARS
AT THE CRBRP SITE AREA

Time Period (hours)	Rainfall (inches)
0.5	2.50
1.0	3.00
2.0	3.75
3.0	4.00
6.0	4.80
12.0	5.80
24.0	6.50

TABLE 2.6-3

MONTHLY DISTRIBUTION OF SEVERE WEATHER - OAK RIDGE CITY OFFICE*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Snow, Ice Pellets+ 1.0 inch or more	1	1	**	0	0	0	0	0	0	0	0	1
Thunderstorms++	1	2	3	5	8	9	11	9	3	1	1	1

*Mean number of days

**Less than one-half day

+1953-1973

++1949-1964

TABLE 2.6-4

MONTHLY CLIMATOLOGICAL TEMPERATURE DATA
OAK RIDGE AREA STATION, X-10[1]
1945-1964

Month	Climatological Standard Normals 1931-1960: Mean Monthly (°F)	Daily Maximum (°F)	Daily Minimum (°F)	Highest Temp. (°F)	Lowest Temp. (°F)
December	40.4	49.4	31.3	76	-5
January	40.1	48.9	31.2	77	-8
February	41.7	51.6	31.8	77	0
Winter	40.7	50.0	31.4	77	-8
March	48.0	58.9	37.0	87	4
April	58.2	70.0	46.3	89	24
May	66.9	79.0	54.8	94	32
Spring	57.7	69.3	46.0	94	4
June	74.7	86.1	63.3	99	41
July	77.4	88.0	66.7	103	49
August	76.5	87.4	65.6	99	44
Summer	76.2	87.2	65.2	103	41
September	71.1	83.0	59.2	103	33
October	60.0	72.2	47.7	91	21
November	47.6	58.6	36.5	83	4
Fall	59.6	71.3	47.6	103	4
Annual	58.5	69.4	47.6	103	-8
Oak Ridge City Office[4] Climatological Standard Normals 1941-1970					
Annual	57.8	68.6	47.0	105*	-9*
Knoxville Vicinity[3] Climatological Standard Normals 1941-1970					
Annual	59.7	69.8	49.5	104**	-16**

*May 1947 - October 1974

**1874 - October 1974

TABLE 2.6-5

MONTHLY WIND DATA

	Oak Ridge City Office*		Knoxville Airport**		Area Station X-10***		CRBRP Meteorological Tower[+]			
							75 Foot Level		200 Foot Level	
Month	Average Speed (mph)	Prevailing Direction	Average Speed (mph)	Prevailing Direction	Average Speed (mph)	Prevailing Direction	Average Speed (mph)	Prevailing Direction	Average Speed (mph)	Prevailing Direction
January	4.8	SW	8.2	NE	5.3	SSW	4.7	SW	8.7	SW
February	5.0	ENE	8.7	NE	6.0	SSW	7.6	WNW	8.3	SW
March	5.3	SW	9.2	NE	6.8	WSW	7.6	SW	14.3	SW
April	5.7	SW	9.3	WSW	7.0	SSW	7.6	SW	11.6	SW
May	4.5	SW	7.4	SW	6.2	NE	7.8	SW	8.4	SW
June	4.2	SW	6.7	SW	6.2	WSW	6.0	SW	8.7	SW
July	3.9	SW	6.3	WSW	4.2	SSW	7.2	SW	8.1	SW
August	3.7	E	5.7	NE	1.5	SSW	3.8	SW	4.3	SW
September	3.8	E	5.9	NE	2.9	NNE	3.1	E	3.4	ENE
October	3.6	E	5.9	NE	2.9	NNE	3.0	SW	3.6	SW
November	4.1	E	7.2	NE	3.2	N	4.7	SW	8.3	SW
December	4.5	SW	7.6	NE	4.3	NNE	4.6	WNW	6.0	ENE
Annual	4.4	SW	7.3	NE	4.7	SSW	4.9	SW	6.7	SW

*16-year record on wind speed, 13-year record on prevailing direction(4)
**31-year record on wind speed, 14-year record on prevailing direction(3)
***1-year record(25) (102 feet, sensor elevation)

TABLE 2.6-6

MONTHLY AVERAGE RELATIVE HUMIDITY VALUES[3]

FOR KNOXVILLE AIRPORT

1961-1973

Month	Relative Humidity at Indicated Time (E.S.T.)				
	0100	0700	1300	1900	Average
January	76	79	63	64	71
February	71	77	60	59	67
March	69	78	54	54	64
April	70	78	51	52	63
May	77	83	54	56	68
June	84	88	59	62	73
July	86	90	62	66	76
August	87	92	61	66	77
September	86	91	58	66	75
October	83	88	55	62	72
November	78	83	59	65	71
December	76	80	64	67	72
Year	79	84	58	62	71

TABLE 2.6-7

FREQUENCY DISTRIBUTION OF RELATIVE HUMIDITIES ACCORDING TO AMBIENT TEMPERATURES FOR BULL RUN STEAM PLANT

Temp., °F	5	15	25	35	45	55	65	75	85	93	97	100
-25	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
-5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	0.12	0.09	0.02	0.03	0.05
15	<0.01	<0.01	<0.01	<0.01	0.14	0.30	0.40	0.29	0.12	0.01	0.01	0.01
25	<0.01	<0.01	<0.01	0.15	0.57	0.96	1.08	1.00	0.72	0.16	0.05	0.04
32	<0.01	<0.01	0.01	0.20	0.43	0.76	0.98	1.42	1.19	0.22	0.10	0.07
37	<0.01	<0.01	0.05	0.32	0.51	0.78	1.20	1.46	1.48	0.31	0.09	0.06
45	<0.01	<0.01	0.20	0.78	1.40	2.01	2.44	2.81	3.91	1.38	0.81	0.29
55	<0.01	0.01	0.31	1.00	1.46	1.74	1.86	2.55	3.92	2.49	1.35	0.59
65	<0.01	0.01	0.38	1.00	1.27	1.64	2.25	3.58	7.14	3.26	2.13	0.84
75	0.01	0.02	0.23	0.69	0.97	2.07	3.23	4.00	4.67	1.54	0.45	0.21
85	0.02	<0.01	0.03	0.26	0.82	2.15	2.43	1.01	0.10	0.01	<0.01	<0.01
95	<0.01	<0.01	<0.01	0.02	0.05	0.11	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
105	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
115	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 2.6-8

PRECIPITATION DATA
OAK RIDGE AREA STATION, X-10[1]

1944-1964

Month	Monthly Average* (inches)	Monthly Maximum (inches)	Monthly Minimum (inches)	Maximum in 24 Hours (inches)
December	5.22	10.28	1.98	4.38
January	5.24	12.37	1.11	3.96
February	5.39	10.01	1.89	3.23
Winter	15.85			
March	5.44	9.69	2.06	3.84
April	4.14	8.54	1.25	2.39
May	3.48	7.01	0.90	2.09
Spring	13.06			
June	3.38	7.55	1.18	3.08
July	5.31	10.19	2.14	3.74
August	4.02	10.31	0.50	3.31
Summer	12.71			
September	3.59	12.84	0.21	7.75
October	2.82	6.43	0.00	2.32
November	3.49	12.00	1.01	3.20
Fall	9.90			
Annual	51.52	12.84	0.00	7.75

*Standard climatological normals (1931-1960)

TABLE 2.6-9

SNOW AND ICE PELLET DATA FOR OAK RIDGE CITY OFFICE[4]

1948 - OCTOBER 1974

	Snow, Ice Pellets (inches)		
Month	Mean* Total	Maximum Monthly	Maximum In 24 Hours
January	3.2	9.6	8.3
February	2.9	11.3	9.1
March	1.5	21.0	12.0
April	T	0.3	0.3
May	0.0	0.0	0.0
June	0.0	0.0	0.0
July	0.0	0.0	0.0
August	0.0	0.0	0.0
September	0.0	0.0	0.0
October	T	T	T
November	0.5	6.5	6.5
December	2.2	14.8	10.8
Year	10.3	21.0	12.0

Maximum Annual 41.4 inches (1959-1960 snowfall season)

*1949-1973

T = Trace

TABLE 2.6-10

MONTHLY MEAN NUMBER OF HEAVY FOG* DAYS FOR KNOXVILLE**
AND OAK RIDGE CITY OFFICE+

	Fog Days (mean number)												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Knoxville	3	2	1	1	2	2	2	3	4	5	3	2	31
Oak Ridge	1	1	1	1	2	2	3	4	4	8	6	2	34

*Visibility less than 1/4-mile
**31-year record (1943-1973)[3]
+14-year record (1951-1964)[4]

TABLE 2.6-11

FOG OCCURRENCE DATA LISTING MEAN NUMBER OF DAYS FOR JANUARY 1964 THROUGH OCTOBER 1970[24]

Visibility Less Than Stated Value

	Melton Hill Lake at Bull Run Creek, Clinch River Mile 46.4		Melton Hill Lake at Dam, Clinch River Mile 23.1	
Month	<1100 yards	<550 yards	<1100 yards	<550 yards
January	3.08	2.00	4.46	4.31
February	3.29	1.57	5.00	4.29
March	1.86	1.14	5.14	4.14
April	2.29	0.86	6.00	4.86
May	5.86	3.71	8.43	7.14
June	6.71	3.29	11.71	9.86
July	12.29	7.43	12.57	10.14
August	14.71	9.42	14.14	12.43
September	13.43	7.56	16.00	15.00
October	10.00	8.43	14.86	14.00
November	11.00	6.17	12.83	12.17
December	6.00	2.84	8.33	7.67
Annual	90.52	54.42	119.47	106.01

TABLE 2.6-12

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES

STABILITY CLASS A
DELTA T $\leq$-1.9 DEG. C/100M

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV 30, 1972

Wind Direction	WIND SPEED (MPH) 0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.24	0.41	0.35	0.09	0.01	0.00	1.10
NNE	0.48	1.26	1.12	0.40	0.03	0.00	3.29
NE	0.16	0.55	0.66	0.18	0.03	0.00	1.58
ENE	0.15	0.75	0.69	0.19	0.01	0.00	1.79
E	0.09	0.22	0.10	0.01	0.00	0.00	0.42
ESE	0.06	0.16	0.08	0.01	0.00	0.00	0.31
SE	0.10	0.11	0.05	0.01	0.00	0.00	0.27
SSE	0.10	0.35	0.15	0.11	0.01	0.00	0.72
S	0.09	0.29	0.41	0.24	0.01	0.00	1.04
SSW	0.22	1.05	1.20	0.61	0.09	0.01	3.18
SW	0.16	0.51	0.46	0.23	0.07	0.00	1.43
WSW	0.32	0.94	1.09	0.41	0.06	0.01	2.83
W	0.23	0.24	0.19	0.13	0.01	0.00	0.80
WNW	0.14	0.29	0.10	0.02	0.00	0.00	0.55
NW	0.05	0.07	0.03	0.01	0.00	0.00	0.16
NNW	0.05	0.06	0.08	0.01	0.00	0.00	0.20
SUBTOTAL	2.64	7.26	6.76	2.66	0.33	0.02	19.67

CALM = 0.23

LOST RECORD = 0.0

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
TEMPERATURE INSTRUMENTS AT 5 AND 102 FT ABOVE GROUND.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-13

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES

STABILITY CLASS B
-1.9< Delta-T ≤-1.7 DEG. C/100M

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV. 30, 1972

WIND SPEED (MPH)

Wind Direction	0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.01	0.06	0.02	0.01	0.00	0.00	0.10
NNE	0.07	0.11	0.06	0.03	0.01	0.00	0.28
NE	0.05	0.07	0.05	0.05	0.00	0.00	0.22
ENE	0.05	0.06	0.03	0.00	0.00	0.00	0.14
E	0.01	0.05	0.00	0.00	0.00	0.00	0.06
ESE	0.00	0.01	0.00	0.00	0.00	0.00	0.01
SE	0.00	0.01	0.00	0.00	0.00	0.00	0.01
SSE	0.01	0.03	0.01	0.05	0.00	0.00	0.10
S	0.00	0.02	0.03	0.00	0.02	0.00	0.07
SSW	0.03	0.05	0.10	0.05	0.03	0.01	0.27
SW	0.00	0.02	0.09	0.02	0.00	0.00	0.13
WSW	0.02	0.13	0.11	0.06	0.01	0.00	0.33
W	0.02	0.02	0.06	0.02	0.00	0.00	0.12
WNW	0.01	0.02	0.03	0.01	0.00	0.00	0.07
NW	0.01	0.00	0.00	0.00	0.00	0.00	0.01
NNW	0.00	0.02	0.01	0.00	0.00	0.00	0.03
SUBTOTAL	0.29	0.68	0.60	0.30	0.07	0.01	1.95

CALM = 0.05

LOST RECORD = 0.0

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
TEMPERATURE INSTRUMENTS AT 5 and 102 FT ABOVE GROUND.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-14

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES

STABILITY CLASS C
-1.7< DELTA-T ≤-1.5 DEG. C/100M

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV. 30, 1972

WIND SPEED (MPH)

Wind Direction	0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.07	0.10	0.05	0.01	0.00	0.00	0.23
NNE	0.06	0.40	0.18	0.06	0.00	0.00	0.70
NE	0.07	0.19	0.07	0.00	0.00	0.00	0.33
ENE	0.06	0.14	0.08	0.03	0.00	0.00	0.31
E	0.00	0.06	0.01	0.00	0.00	0.00	0.07
ESE	0.03	0.03	0.02	0.00	0.00	0.00	0.08
SE	0.01	0.03	0.00	0.00	0.00	0.00	0.04
SSE	0.02	0.07	0.05	0.03	0.01	0.00	0.18
S	0.03	0.09	0.05	0.09	0.01	0.00	0.27
SSW	0.07	0.30	0.17	0.11	0.01	0.00	0.66
SW	0.06	0.17	0.11	0.00	0.00	0.00	0.34
WSW	0.08	0.19	0.15	0.03	0.00	0.00	0.45
W	0.06	0.07	0.05	0.05	0.00	0.00	0.23
WNW	0.06	0.08	0.08	0.01	0.00	0.00	0.23
NW	0.01	0.08	0.01	0.00	0.00	0.00	0.10
NNW	0.01	0.02	0.02	0.00	0.00	0.00	0.05
SUBTOTAL	0.70	2.02	1.10	0.42	0.03	0.00	4.27

CALM = 0.05

LOST RECORD = 0.0

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
TEMPERATURE INSTRUMENTS AT 5 AND 102 FT ABOVE GROUND.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-15

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES

STABILITY CLASS D
-1.5< DELTA-T ≤ -0.5 DEG. C/100M

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV. 30, 1972

Wind Direction	WIND SPEED (MPH) 0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥24.5	Total
N	0.16	0.29	0.18	0.03	0.00	0.00	0.66
NNE	0.33	0.49	0.33	0.08	0.00	0.01	1.24
NE	0.21	0.27	0.07	0.05	0.02	0.00	0.62
ENE	0.23	0.35	0.17	0.00	0.00	0.00	0.75
E	0.07	0.14	0.03	0.00	0.00	0.00	0.24
ESE	0.16	0.13	0.03	0.00	0.00	0.00	0.32
SE	0.08	0.06	0.02	0.00	0.01	0.00	0.17
SSE	0.07	0.11	0.06	0.05	0.00	0.00	0.29
S	0.13	0.32	0.11	0.03	0.00	0.00	0.59
SSW	0.37	0.73	0.47	0.24	0.06	0.00	1.87
SW	0.24	0.37	0.21	0.06	0.03	0.00	0.91
WSW	0.26	0.61	0.45	0.13	0.03	0.00	1.48
W	0.18	0.19	0.16	0.05	0.00	0.00	0.58
WNW	0.17	0.17	0.14	0.03	0.01	0.00	0.52
NW	0.13	0.05	0.01	0.00	0.01	0.00	0.20
NNW	0.06	0.02	0.05	0.00	0.00	0.00	0.13
SUBTOTAL	2.85	4.30	2.49	0.75	0.17	0.01	10.57

CALM = 0.17

LOST RECORDS = 0.0

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
TEMPERATURE INSTRUMENTS AT 5 AND 102 FT ABOVE GROUND.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-16

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES

STABILITY CLASS E
-0.5< DELTA -T ≤ 1.5 DEG. C/100M

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV. 30, 1972

WIND SPEED (MPH)

Wind Direction	0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	≥ 24.5	Total
N	0.89	0.79	0.43	0.11	0.00	0.00	2.22
NNE	0.95	1.55	0.59	0.10	0.01	0.00	3.20
NE	0.39	0.54	0.25	0.02	0.01	0.00	1.21
ENE	0.54	0.61	0.16	0.01	0.00	0.01	1.33
E	0.27	0.09	0.03	0.00	0.00	0.00	0.39
ESE	0.29	0.10	0.05	0.01	0.00	0.00	0.45
SE	0.15	0.15	0.07	0.00	0.00	0.00	0.37
SSE	0.46	0.26	0.13	0.03	0.01	0.00	0.89
S	0.41	0.41	0.18	0.05	0.03	0.00	1.08
SSW	0.66	1.05	0.79	0.29	0.07	0.01	2.87
SW	0.72	0.69	0.33	0.11	0.03	0.00	1.88
WSW	0.65	0.86	0.75	0.16	0.03	0.00	2.45
W	0.66	0.53	0.39	0.18	0.02	0.00	1.78
WNW	0.58	0.72	0.37	0.19	0.01	0.00	1.87
NW	0.34	0.23	0.09	0.00	0.01	0.00	0.67
NNW	0.24	0.17	0.18	0.01	0.00	0.00	0.60
SUBTOTAL	8.20	8.75	4.79	1.27	0.23	0.02	23.26

CALM = 4.22

LOST RECORD = 0.0

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
TEMPERATURE INSTRUMENTS AT 5 and 102 FT ABOVE GROUND.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-17

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES

STABILITY CLASS F
1.5< DELTA-T $\leq$ 4.0 DEG. C/100M

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV. 30, 1972

WIND SPEED (MPH)

Wind Direction	0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	$\geq$ 24.5	Total
N	0.62	0.48	0.15	0.05	0.02	0.00	1.32
NNE	0.78	0.81	0.27	0.07	0.01	0.00	1.94
NE	0.42	0.55	0.25	0.02	0.00	0.00	1.24
ENE	0.57	0.41	0.03	0.00	0.00	0.00	1.01
E	0.24	0.08	0.02	0.00	0.00	0.00	0.34
ESE	0.22	0.06	0.01	0.00	0.00	0.00	0.29
SE	0.13	0.07	0.01	0.00	0.00	0.01	0.22
SSE	0.49	0.19	0.05	0.00	0.01	0.00	0.74
S	0.33	0.25	0.07	0.08	0.03	0.00	0.76
SSW	0.56	0.59	0.42	0.30	0.15	0.03	2.05
SW	0.43	0.37	0.15	0.06	0.01	0.00	1.02
WSW	0.70	0.45	0.37	0.09	0.05	0.00	1.66
W	0.64	0.29	0.07	0.02	0.02	0.00	1.04
WNW	0.57	0.38	0.11	0.01	0.02	0.01	1.10
NW	0.14	0.07	0.03	0.00	0.01	0.00	0.25
NNW	0.21	0.13	0.00	0.00	0.00	0.00	0.34
SUBTOTAL	7.05	5.18	2.01	0.70	0.33	0.05	15.32

CALM = 4.85

LOST RECORD = 0.0

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
TEMPERATURE INSTRUMENTS AT 5 AND 102 FT ABOVE GROUND.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-18

JOINT PERCENTAGE FREQUENCIES OF WIND DIRECTION AND WIND SPEED
FOR DIFFERENT STABILITY CLASSES

STABILITY CLASS G

DELTA T > 4.0 DEG. C/100M

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV. 30, 1972

Wind Direction	0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	0.46	0.35	0.13	0.02	0.00	0.00	0.96
NNE	0.63	0.94	0.21	0.01	0.00	0.00	1.79
NE	0.33	0.26	0.15	0.00	0.00	0.00	0.74
ENE	0.64	0.51	0.03	0.00	0.00	0.00	1.18
E	0.21	0.14	0.01	0.00	0.00	0.00	0.36
ESE	0.19	0.03	0.00	0.00	0.00	0.00	0.22
SE	0.06	0.01	0.02	0.00	0.01	0.00	0.10
SSE	0.46	0.25	0.02	0.00	0.00	0.00	0.73
S	0.26	0.11	0.01	0.02	0.07	0.00	0.47
SSW	0.72	0.80	0.13	0.03	0.08	0.07	1.83
SW	0.37	0.50	0.07	0.00	0.02	0.00	0.96
WSW	0.87	0.70	0.13	0.00	0.00	0.01	1.71
W	0.31	0.19	0.01	0.00	0.00	0.00	0.51
WNW	0.38	0.18	0.01	0.00	0.00	0.00	0.57
NW	0.14	0.02	0.03	0.01	0.00	0.00	0.20
NNW	0.13	0.16	0.03	0.02	0.00	0.00	0.34
SUBTOTAL	6.16	5.15	0.99	0.11	0.18	0.08	12.67

CALM = 2.54

LOST RECORD = 0.0

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
TEMPERATURE INSTRUMENTS AT 5 AND 102 FT ABOVE GROUND.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-19

PERCENT OCCURRENCE OF WIND SPEED
FOR ALL WIND DIRECTIONS

X-10 (OAK RIDGE) METEOROLOGICAL FACILITY

DEC. 1, 1971 - NOV. 30, 1972

Wind Direction	0.6-3.4	3.5-7.4	7.5-12.4	12.5-18.4	18.5-24.4	>24.5	Total
N	2.45	2.48	1.31	0.33	0.03	0.0	6.60
NNE	3.29	5.57	2.77	0.75	0.07	0.01	12.46
NE	1.62	2.44	1.50	0.32	0.07	0.0	5.95
ENE	2.23	2.84	1.20	0.24	0.01	0.01	6.53
E	0.89	0.77	0.22	0.01	0.0	0.0	1.89
ESE	0.95	0.53	0.19	0.02	0.0	0.0	1.69
SE	0.53	0.45	0.17	0.01	0.02	0.01	1.19
SSE	1.61	1.28	0.46	0.27	0.05	0.0	3.67
S	1.26	1.50	0.87	0.51	0.18	0.0	4.32
SSW	2.63	4.57	3.28	1.62	0.49	0.14	-12.73
SW	1.98	2.63	1.42	0.48	0.17	0.0	6.68
WSW	2.90	3.86	3.04	0.88	0.18	0.02	10.88
W	2.10	1.53	0.93	0.45	0.06	0.0	5.07
WNW	1.91	1.84	0.85	0.29	0.05	0.01	4.95
NW	0.81	0.51	0.22	0.02	0.03	0.0	1.59
NNW	0.69	0.58	0.38	0.05	0.0	0.0	1.70
SUBTOTAL	27.85	33.38	18.81	6.25	1.41	0.20	87.90

CALM = 12.10

LOST RECORD = 0.42

MET. FACILITY AT X-10 LOCATED 4.5 MI. NE OF CRBRP SITE. ELEV. 886 FT MSL.
WIND INSTRUMENTS AT 102 FT ABOVE GROUND.

NOTE - TOTAL OF ALL COLUMNS AND CALM IS 100 PERCENT OF TOTAL GOOD RECORD.

TABLE 2.6-20

PERCENTAGE FREQUENCY OF STABILITY DISTRIBUTION FOR TWO TEMPERATURE DIFFERENTIALS FOR THE CRBRP METEOROLOGICAL TOWER

(April 3, 1974 through June 30, 1974)

Pasquill Stability Class	Temperature Difference Between 200 Foot Level and 75 Foot Level		Temperature Difference Between 200 Foot Level and 33 Foot Level	
	75-Foot Wind Level	200-Foot Wind Level	75-Foot Wind Level	200-Foot Wind Level
A	5.52	4.34	2.29	2.01
B	12.14	10.76	4.61	4.13
C	5.52	4.87	7.06	6.33
D	28.65	25.85	35.58	32.33
E	29.45	29.06	30.27	29.55
F	11.34	14.85	11.71	14.96
G	7.38	9.78	8.49	10.68

TABLE 2.6-21

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS A
CRBRP METEOROLOGICAL TOWER, 75-FOOT LEVEL
JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00002	0.00013	0.00052	0.00013	0.00000	0.00000	0.00000	0.00000	0.00080
NNE	0.00015	0.00103	0.00116	0.00039	0.00000	0.00000	0.00000	0.00000	0.00274
NE	0.00015	0.00078	0.00259	0.00013	0.00026	0.00000	0.00000	0.00000	0.00390
ENE	0.00054	0.00220	0.00530	0.00323	0.00181	0.00000	0.00000	0.00000	0.01308
E	0.00015	0.00323	0.00504	0.00272	0.00052	0.00000	0.00000	0.00000	0.01166
ESE	0.00028	0.00207	0.00323	0.00207	0.00026	0.00000	0.00000	0.00000	0.00791
SE	0.00015	0.00091	0.00310	0.00052	0.00039	0.00000	0.00000	0.00000	0.00506
SSE	0.00015	0.00155	0.00207	0.00052	0.00000	0.00000	0.00000	0.00000	0.00429
S	0.00028	0.00129	0.00259	0.00116	0.00026	0.00013	0.00000	0.00000	0.00571
SSW	0.00041	0.00285	0.00621	0.00388	0.00220	0.00194	0.00000	0.00000	0.01748
SW	0.00067	0.00414	0.00608	0.00582	0.00440	0.00168	0.00039	0.00013	0.02330
WSW	0.00028	0.00491	0.00504	0.00168	0.00078	0.00039	0.00026	0.00000	0.01334
W	0.00041	0.00297	0.00168	0.00091	0.00065	0.00000	0.00026	0.00000	0.00687
WNW	0.00002	0.00142	0.00155	0.00142	0.00155	0.00078	0.00000	0.00000	0.00675
NW	0.00002	0.00052	0.00013	0.00103	0.00103	0.00065	0.00000	0.00000	0.00338
NNW	0.00002	0.00026	0.00026	0.00000	0.00026	0.00000	0.00000	0.00000	0.00080
TOTAL	0.00375	0.03026	0.04656	0.02561	0.01436	0.00556	0.00091	0.00013	0.12714

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00039

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-22

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS B

CRBRP METEOROLOGICAL TOWER, 75-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00014	0.00065	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00092
NNE	0.00001	0.00013	0.00026	0.00065	0.00013	0.00000	0.00000	0.00000	0.00117
NE	0.00014	0.00052	0.00103	0.00103	0.00013	0.00000	0.00000	0.00000	0.00286
ENE	0.00027	0.00078	0.00168	0.00052	0.00013	0.00000	0.00000	0.00000	0.00337
E	0.00027	0.00103	0.00194	0.00103	0.00026	0.00000	0.00000	0.00000	0.00454
ESE	0.00014	0.00065	0.00233	0.00026	0.00000	0.00000	0.00000	0.00000	0.00337
SE	0.00014	0.00026	0.00155	0.00039	0.00026	0.00000	0.00000	0.00000	0.00260
SSE	0.00053	0.00065	0.00091	0.00000	0.00000	0.00000	0.00000	0.00000	0.00208
S	0.00001	0.00026	0.00116	0.00039	0.00013	0.00013	0.00000	0.00000	0.00208
SSW	0.00027	0.00039	0.00181	0.00078	0.00310	0.00116	0.00000	0.00000	0.00751
SW	0.00027	0.00181	0.00285	0.00233	0.00491	0.00091	0.00000	0.00000	0.01307
WSW	0.00014	0.00181	0.00168	0.00155	0.00065	0.00039	0.00013	0.00000	0.00635
W	0.00001	0.00039	0.00078	0.00181	0.00103	0.00039	0.00000	0.00000	0.00441
WNW	0.00001	0.00103	0.00103	0.00065	0.00233	0.00013	0.00000	0.00000	0.00518
NW	0.00014	0.00026	0.00052	0.00026	0.00091	0.00026	0.00000	0.00000	0.00234
NNW	0.00001	0.00000	0.00078	0.00039	0.00013	0.00000	0.00000	0.00000	0.00130
TOTAL	0.00246	0.01061	0.02043	0.01203	0.01410	0.00336	0.00013	0.00000	0.06311

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00013

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-23

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS C

CRBRP METEOROLOGICAL TOWER, 75-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00017	0.00000	0.00039	0.00013	0.00013	0.00013	0.00000	0.00000	0.00095
NNE	0.00017	0.00039	0.00039	0.00013	0.00026	0.00000	0.00000	0.00000	0.00133
NE	0.00017	0.00026	0.00065	0.00000	0.00000	0.00000	0.00000	0.00000	0.00107
ENE	0.00004	0.00052	0.00129	0.00052	0.00000	0.00000	0.00000	0.00000	0.00237
E	0.00017	0.00142	0.00118	0.00039	0.00000	0.00000	0.00000	0.00000	0.00314
ESE	0.00030	0.00052	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00095
SE	0.00082	0.00052	0.00026	0.00013	0.00000	0.00000	0.00000	0.00000	0.00172
SSE	0.00030	0.00052	0.00039	0.00000	0.00000	0.00000	0.00000	0.00000	0.00120
S	0.00017	0.00052	0.00026	0.00026	0.00000	0.00026	0.00000	0.00000	0.00146
SSW	0.00004	0.00129	0.00091	0.00052	0.00091	0.00013	0.00013	0.00000	0.00392
SW	0.00017	0.00116	0.00181	0.00181	0.00259	0.00155	0.00000	0.00000	0.00909
WSW	0.00017	0.00181	0.00116	0.00091	0.00091	0.00039	0.00000	0.00000	0.00534
W	0.00004	0.00078	0.00052	0.00039	0.00052	0.00013	0.00000	0.00000	0.00237
WNW	0.00004	0.00116	0.00103	0.00091	0.00155	0.00078	0.00000	0.00000	0.00547
NW	0.00004	0.00078	0.00052	0.00039	0.00091	0.00026	0.00000	0.00000	0.00289
NNW	0.00004	0.00000	0.00065	0.00013	0.00026	0.00000	0.00000	0.00000	0.00107
TOTAL	0.00285	0.01164	0.01151	0.00660	0.00802	0.00362	0.00013	0.00000	0.04436

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00065

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*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-24

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS D

CRBRP METEOROLOGICAL TOWER, 75-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00113	0.00297	0.00103	0.00129	0.00065	0.00000	0.00000	0.00000	0.00708
NNE	0.00371	0.00608	0.00233	0.00091	0.00013	0.00000	0.00000	0.00000	0.01315
NE	0.00281	0.00685	0.00440	0.00052	0.00000	0.00000	0.00000	0.00000	0.01458
ENE	0.00371	0.00750	0.00647	0.00103	0.00000	0.00000	0.00000	0.00000	0.01872
E	0.00333	0.01125	0.00621	0.00194	0.00013	0.00000	0.00000	0.00000	0.02285
ESE	0.00449	0.00556	0.00375	0.00091	0.00013	0.00000	0.00000	0.00000	0.01484
SE	0.00423	0.00310	0.00155	0.00065	0.00052	0.00000	0.00000	0.00000	0.01005
SSE	0.00203	0.00129	0.00116	0.00013	0.00026	0.00000	0.00000	0.00000	0.00488
S	0.00255	0.00285	0.00207	0.00129	0.00116	0.00078	0.00000	0.00000	0.01070
SSW	0.00229	0.00530	0.00556	0.00362	0.00479	0.00246	0.00000	0.00000	0.02402
SW	0.00203	0.00854	0.00776	0.00970	0.00957	0.00517	0.00026	0.00000	0.04303
WSW	0.00151	0.00479	0.00466	0.00569	0.00427	0.00272	0.00065	0.00000	0.02428
W	0.00126	0.00349	0.00427	0.00129	0.00336	0.00065	0.00000	0.00000	0.01432
WNW	0.00177	0.00349	0.00582	0.00944	0.01436	0.00116	0.00000	0.00000	0.03605
NW	0.00216	0.00388	0.00297	0.00388	0.00685	0.00026	0.00000	0.00000	0.02001
NNW	0.00190	0.00427	0.00285	0.00103	0.00078	0.00000	0.00000	0.00000	0.01083
TOTAL	0.04087	0.08122	0.06286	0.04333	0.04695	0.01319	0.00091	0.00000	0.28932

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00763

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-26

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS F

CRBRP METEOROLOGICAL TOWER, 75-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00564	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00641
NNE	0.00745	0.00297	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000	0.01068
NE	0.00628	0.00168	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00809
ENE	0.00861	0.00246	0.00013	0.00013	0.00000	0.00000	0.00000	0.00000	0.01133
E	0.00771	0.00272	0.00091	0.00000	0.00000	0.00000	0.00000	0.00000	0.01133
ESE	0.00887	0.00155	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.01042
SE	0.00783	0.00065	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00848
SSE	0.00693	0.00065	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00758
S	0.01081	0.00129	0.00039	0.00000	0.00000	0.00000	0.00000	0.00000	0.01249
SSW	0.00758	0.00246	0.00013	0.00026	0.00000	0.00000	0.00000	0.00000	0.01042
SW	0.00628	0.00362	0.00103	0.00052	0.00013	0.00000	0.00000	0.00000	0.01159
WSW	0.00577	0.00091	0.00078	0.00000	0.00000	0.00000	0.00000	0.00000	0.00745
W	0.00408	0.00039	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00460
WNW	0.00564	0.00091	0.00000	0.00013	0.00013	0.00000	0.00000	0.00000	0.00680
NW	0.00408	0.00026	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00447
NNW	0.00460	0.00129	0.00026	0.00013	0.00000	0.00000	0.00000	0.00000	0.00628
TOTAL	0.10812	0.02457	0.00427	0.00116	0.00026	0.00000	0.00000	0.00000	0.13839

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.04669

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-27

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS G CRBRP METEOROLOGICAL TOWER, 75-FOOT LEVEL JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00547	0.00116	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00664
NNE	0.00418	0.00194	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00612
NE	0.00392	0.00052	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00457
ENE	0.00444	0.00155	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00612
E	0.00664	0.00155	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00819
ESE	0.00729	0.00052	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00793
SE	0.00625	0.00065	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00703
SSE	0.00651	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00677
S	0.00793	0.00103	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00897
SSW	0.00741	0.00285	0.00000	0.00013	0.00000	0.00000	0.00000	0.00000	0.01039
SW	0.00522	0.00207	0.00052	0.00000	0.00000	0.00013	0.00000	0.00000	0.00793
WSW	0.00522	0.00129	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00664
W	0.00405	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00418
WNW	0.00496	0.00026	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00535
NW	0.00418	0.00052	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00470
NNW	0.00509	0.00181	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00703
TOTAL	0.08872	0.01811	0.00142	0.00013	0.00000	0.00013	0.00000	0.00000	0.10851

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.03996

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*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-28

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR ALL STABILITY CLASSES
CRBRP METEOROLOGICAL TOWER, 75-FOOT LEVEL
JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.01803	0.00841	0.00285	0.00194	0.00078	0.00013	0.00000	0.00000	0.03214
NNE	0.02276	0.01836	0.00518	0.00208	0.00052	0.00000	0.00000	0.00000	0.04890
NE	0.01953	0.01610	0.00971	0.00194	0.00039	0.00000	0.00000	0.00000	0.04766
ENE	0.02703	0.02393	0.01720	0.00543	0.00194	0.00000	0.00000	0.00000	0.07553
E	0.02704	0.02922	0.01748	0.01216	0.00091	0.00000	0.00000	0.00000	0.08681
ESE	0.03144	0.01410	0.01086	0.00360	0.00052	0.00000	0.00000	0.00000	0.06052
SE	0.02936	0.00936	0.00750	0.00221	0.00169	0.00013	0.00000	0.00000	0.05025
SSE	0.02354	0.00686	0.00492	0.00091	0.00039	0.00000	0.00000	0.00000	0.03662
S	0.02949	0.01009	0.00738	0.00323	0.00194	0.00143	0.00000	0.00000	0.05356
SSW	0.02509	0.01993	0.01734	0.01139	0.01216	0.00582	0.00013	0.00000	0.09186
SW	0.01966	0.02832	0.02794	0.02393	0.02561	0.00996	0.00066	0.00013	0.13621
WSW	0.01695	0.01862	0.01724	0.01319	0.00933	0.00389	0.00104	0.00000	0.08026
W	0.01255	0.00918	0.00880	0.00543	0.00634	0.00130	0.00026	0.00000	0.04386
WNW	0.01591	0.00982	0.01215	0.01643	0.02212	0.00337	0.00000	0.00000	0.07980
NW	0.01370	0.00790	0.00608	0.00763	0.01048	0.00143	0.00000	0.00000	0.04794
NNW	0.01539	0.01035	0.00648	0.00194	0.00156	0.00000	0.00000	0.00000	0.03572
TOTAL	0.34747	0.24055	0.17911	0.11344	0.09668	0.02746	0.00209	0.00013	1.00000

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.12403

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-29

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS A

CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00000	0.00013	0.00013	0.00000	0.00026	0.00013	0.00013	0.00000	0.00079
NNE	0.00000	0.00066	0.00013	0.00052	0.00144	0.00026	0.00000	0.00000	0.00301
NE	0.00000	0.00026	0.00131	0.00183	0.00314	0.00105	0.00000	0.00000	0.00760
ENE	0.00000	0.00066	0.00275	0.00485	0.00577	0.00131	0.00000	0.00000	0.01533
E	0.00013	0.00105	0.00092	0.00197	0.00380	0.00052	0.00000	0.00000	0.00839
ESE	0.00000	0.00066	0.00092	0.00052	0.00157	0.00013	0.00000	0.00000	0.00380
SE	0.00000	0.00026	0.00052	0.00183	0.00131	0.00013	0.00000	0.00000	0.00406
SSE	0.00000	0.00066	0.00118	0.00052	0.00066	0.00039	0.00000	0.00000	0.00341
S	0.00000	0.00066	0.00249	0.00157	0.00092	0.00013	0.00000	0.00000	0.00577
SSW	0.00013	0.00131	0.00275	0.00314	0.00367	0.00301	0.00013	0.00039	0.01454
SW	0.00013	0.00052	0.00445	0.00354	0.00773	0.00668	0.00170	0.00066	0.02542
WSW	0.00013	0.00183	0.00328	0.00092	0.00262	0.00197	0.00052	0.00000	0.01127
W	0.00000	0.00052	0.00144	0.00066	0.00105	0.00066	0.00026	0.00013	0.00472
WNW	0.00000	0.00052	0.00197	0.00105	0.00301	0.00131	0.00026	0.00013	0.00825
NW	0.00000	0.00026	0.00079	0.00118	0.00131	0.00249	0.00013	0.00000	0.00616
NNW	0.00000	0.00105	0.00118	0.00039	0.00131	0.00092	0.00000	0.00000	0.00485
TOTAL	0.00052	0.01101	0.02621	0.02450	0.03957	0.02110	0.00314	0.00131	0.12736

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00000

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-30

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS B
CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL
JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00001	0.00013	0.00026	0.00026	0.00026	0.00000	0.00000	0.00000	0.00093
NNE	0.00001	0.00013	0.00013	0.00013	0.00118	0.00039	0.00000	0.00000	0.00198
NE	0.00001	0.00026	0.00066	0.00039	0.00026	0.00013	0.00000	0.00000	0.00171
ENE	0.00001	0.00079	0.00157	0.00144	0.00144	0.00013	0.00000	0.00000	0.00538
E	0.00001	0.00066	0.00039	0.00092	0.00039	0.00000	0.00000	0.00000	0.00237
ESE	0.00014	0.00039	0.00131	0.00052	0.00013	0.00000	0.00000	0.00000	0.00250
SE	0.00014	0.00013	0.00066	0.00092	0.00013	0.00000	0.00000	0.00000	0.00198
SSE	0.00001	0.00026	0.00118	0.00039	0.00000	0.00013	0.00013	0.00000	0.00211
S	0.00001	0.00039	0.00052	0.00026	0.00052	0.00013	0.00000	0.00000	0.00184
SSW	0.00001	0.00066	0.00131	0.00105	0.00157	0.00118	0.00013	0.00000	0.00591
SW	0.00001	0.00066	0.00223	0.00262	0.00393	0.00511	0.00039	0.00000	0.01495
WSW	0.00014	0.00144	0.00105	0.00052	0.00118	0.00144	0.00039	0.00000	0.00617
W	0.00001	0.00039	0.00118	0.00039	0.00092	0.00079	0.00000	0.00000	0.00368
WNW	0.00001	0.00039	0.00079	0.00131	0.00170	0.00092	0.00000	0.00000	0.00512
NW	0.00001	0.00026	0.00105	0.00052	0.00170	0.00118	0.00000	0.00000	0.00473
NNW	0.00001	0.00039	0.00039	0.00013	0.00052	0.00026	0.00000	0.00000	0.00171
TOTAL	0.00052	0.00734	0.01468	0.01179	0.01585	0.01179	0.00105	0.00000	0.06302

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00013

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-31

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS C

CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00000	0.00000	0.00026	0.00013	0.00013	0.00013	0.00000	0.00000	0.00066
NNE	0.00000	0.00039	0.00026	0.00013	0.00026	0.00000	0.00000	0.00000	0.00105
NE	0.00013	0.00026	0.00013	0.00066	0.00013	0.00013	0.00000	0.00000	0.00144
ENE	0.00013	0.00066	0.00131	0.00118	0.00013	0.00013	0.00000	0.00000	0.00354
E	0.00013	0.00039	0.00092	0.00039	0.00026	0.00000	0.00000	0.00000	0.00210
ESE	0.00026	0.00026	0.00000	0.00013	0.00000	0.00000	0.00000	0.00000	0.00066
SE	0.00013	0.00013	0.00000	0.00026	0.00000	0.00000	0.00000	0.00000	0.00052
SSE	0.00000	0.00013	0.00026	0.00026	0.00000	0.00000	0.00000	0.00000	0.00066
S	0.00039	0.00026	0.00052	0.00013	0.00013	0.00000	0.00000	0.00000	0.00144
SSW	0.00000	0.00052	0.00092	0.00039	0.00118	0.00039	0.00000	0.00000	0.00341
SW	0.00026	0.00131	0.00144	0.00105	0.00314	0.00301	0.00066	0.00013	0.01101
WSW	0.00000	0.00079	0.00131	0.00066	0.00105	0.00079	0.00000	0.00000	0.00459
W	0.00000	0.00079	0.00066	0.00026	0.00026	0.00013	0.00000	0.00000	0.00210
WNW	0.00000	0.00013	0.00039	0.00066	0.00131	0.00144	0.00000	0.00000	0.00393
NW	0.00013	0.00066	0.00066	0.00052	0.00197	0.00079	0.00013	0.00000	0.00485
NNW	0.00026	0.00013	0.00026	0.00039	0.00039	0.00052	0.00013	0.00000	0.00210
TOTAL	0.00183	0.00681	0.00930	0.00721	0.01035	0.00747	0.00092	0.00013	0.04403

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00000

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-32

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS D

CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00066	0.00157	0.00183	0.00039	0.00052	0.00013	0.00000	0.00000	0.00511
NNE	0.00118	0.00249	0.00170	0.00157	0.00210	0.00026	0.00000	0.00000	0.00930
NE	0.00131	0.00197	0.00288	0.00419	0.00197	0.00013	0.00000	0.00000	0.01245
ENE	0.00236	0.00590	0.00983	0.00681	0.00472	0.00013	0.00000	0.00000	0.02974
E	0.00118	0.00550	0.00354	0.00144	0.00079	0.00000	0.00000	0.00000	0.01245
ESE	0.00170	0.00341	0.00236	0.00039	0.00039	0.00013	0.00000	0.00000	0.00839
SE	0.00131	0.00144	0.00118	0.00066	0.00079	0.00039	0.00000	0.00000	0.00577
SSE	0.00052	0.00144	0.00105	0.00052	0.00039	0.00039	0.00000	0.00000	0.00432
S	0.00066	0.00275	0.00197	0.00144	0.00066	0.00026	0.00000	0.00000	0.00773
SSW	0.00131	0.00341	0.00301	0.00249	0.00498	0.00393	0.00066	0.00013	0.01992
SW	0.00118	0.00603	0.00642	0.00563	0.01585	0.01074	0.00249	0.00092	0.04927
WSW	0.00105	0.00354	0.00629	0.00445	0.00760	0.00393	0.00131	0.00052	0.02869
W	0.00052	0.00249	0.00223	0.00183	0.00393	0.00236	0.00000	0.00000	0.01336
WNW	0.00092	0.00354	0.00445	0.00406	0.00930	0.00485	0.00052	0.00000	0.02765
NW	0.00144	0.00328	0.00485	0.00668	0.01441	0.00459	0.00013	0.00000	0.03538
NNW	0.00118	0.00668	0.00314	0.00262	0.00472	0.00210	0.00000	0.00000	0.02044
TOTAL	0.01847	0.05542	0.05673	0.04520	0.07311	0.03433	0.00511	0.00157	0.28996

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00000

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-33

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR
STABILITY CLASS E
CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL
JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00113	0.00236	0.00079	0.00079	0.00052	0.00000	0.00000	0.00000	0.00558
NNE	0.00231	0.00314	0.00052	0.00039	0.00079	0.00000	0.00000	0.00000	0.00715
NE	0.00270	0.00550	0.00314	0.00079	0.00118	0.00013	0.00000	0.00000	0.01344
ENE	0.00349	0.01153	0.00642	0.00537	0.00144	0.00000	0.00000	0.00000	0.02825
E	0.00519	0.00760	0.00354	0.00118	0.00052	0.00013	0.00000	0.00000	0.01816
ESE	0.00506	0.00524	0.00144	0.00079	0.00052	0.00000	0.00000	0.00000	0.01305
SE	0.00322	0.00236	0.00066	0.00039	0.00052	0.00039	0.00013	0.00000	0.00768
SSE	0.00152	0.00118	0.00052	0.00039	0.00039	0.00039	0.00013	0.00000	0.00453
S	0.00191	0.00223	0.00066	0.00039	0.00026	0.00013	0.00000	0.00000	0.00558
SSW	0.00309	0.00406	0.00275	0.00197	0.00262	0.00039	0.00026	0.00000	0.01515
SW	0.00401	0.00825	0.00603	0.00537	0.00917	0.00380	0.00026	0.00013	0.03703
WSW	0.00322	0.00445	0.00380	0.00367	0.00655	0.00144	0.00000	0.00000	0.02314
W	0.00113	0.00144	0.00223	0.00131	0.00197	0.00039	0.00000	0.00000	0.00846
WNW	0.00218	0.00197	0.00144	0.00275	0.00275	0.00092	0.00026	0.00000	0.01226
NW	0.00283	0.00249	0.00118	0.00197	0.00616	0.00131	0.00000	0.00000	0.01593
NNW	0.00362	0.00550	0.00197	0.00131	0.00131	0.00013	0.00000	0.00000	0.01384
TOTAL	0.04665	0.06931	0.03708	0.02883	0.03669	0.00956	0.00105	0.00013	0.22930

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00341

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-34

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS F

CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL

JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00208	0.00170	0.00092	0.00013	0.00026	0.00000	0.00000	0.00000	0.00510
NNE	0.00339	0.00236	0.00052	0.00026	0.00039	0.00000	0.00000	0.00000	0.00693
NE	0.00287	0.00406	0.00170	0.00079	0.00013	0.00026	0.00000	0.00000	0.00981
ENE	0.00379	0.00812	0.00498	0.00131	0.00026	0.00000	0.00000	0.00000	0.01846
E	0.00339	0.00694	0.00105	0.00000	0.00000	0.00000	0.00000	0.00000	0.01139
ESE	0.00457	0.00498	0.00066	0.00026	0.00000	0.00000	0.00000	0.00000	0.01047
SE	0.00208	0.00223	0.00039	0.00013	0.00013	0.00000	0.00000	0.00000	0.00497
SSE	0.00195	0.00079	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000	0.00300
S	0.00156	0.00131	0.00066	0.00026	0.00000	0.00013	0.00000	0.00000	0.00392
SSW	0.00392	0.00380	0.00066	0.00039	0.00066	0.00026	0.00000	0.00000	0.00968
SW	0.00131	0.01048	0.00341	0.00288	0.00197	0.00013	0.00000	0.00000	0.02200
WSW	0.00238	0.00314	0.00262	0.00170	0.00039	0.00013	0.00000	0.00000	0.01047
W	0.00117	0.00131	0.00079	0.00039	0.00000	0.00000	0.00000	0.00000	0.00366
WNW	0.00156	0.00039	0.00105	0.00052	0.00000	0.00000	0.00000	0.00000	0.00353
NW	0.00143	0.00210	0.00052	0.00000	0.00013	0.00013	0.00000	0.00000	0.00431
NNW	0.00287	0.00642	0.00118	0.00013	0.00013	0.00000	0.00000	0.00000	0.01073
TOTAL	0.04232	0.06014	0.02136	0.00917	0.00445	0.00105	0.00000	0.00000	0.13849

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00406

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-35

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR STABILITY CLASS G CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00060	0.00026	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00087
NNE	0.00060	0.00131	0.00039	0.00013	0.00026	0.00000	0.00000	0.00000	0.00270
NE	0.00231	0.00236	0.00118	0.00013	0.00039	0.00000	0.00000	0.00000	0.00637
ENE	0.00178	0.00799	0.00354	0.00092	0.00000	0.00000	0.00000	0.00000	0.01423
E	0.00191	0.00393	0.00039	0.00000	0.00000	0.00000	0.00000	0.00000	0.00624
ESE	0.00205	0.00354	0.00013	0.00000	0.00000	0.00000	0.00000	0.00000	0.00571
SE	0.00165	0.00144	0.00039	0.00026	0.00000	0.00000	0.00000	0.00000	0.00375
SSE	0.00074	0.00039	0.00066	0.00000	0.00013	0.00000	0.00000	0.00000	0.00191
S	0.00165	0.00052	0.00039	0.00013	0.00013	0.00000	0.00000	0.00000	0.00283
SSW	0.00257	0.00197	0.00118	0.00052	0.00105	0.00000	0.00000	0.00000	0.00729
SW	0.00388	0.00708	0.00550	0.00210	0.00249	0.00000	0.00013	0.00000	0.02118
WSW	0.00257	0.00459	0.00629	0.00301	0.00052	0.00000	0.00000	0.00000	0.01698
W	0.00087	0.00210	0.00118	0.00013	0.00000	0.00000	0.00000	0.00000	0.00427
WNW	0.00074	0.00144	0.00066	0.00039	0.00000	0.00000	0.00000	0.00000	0.00322
NW	0.00152	0.00183	0.00039	0.00026	0.00000	0.00013	0.00000	0.00000	0.00414
NNW	0.00270	0.00249	0.00092	0.00000	0.00000	0.00000	0.00000	0.00000	0.00611
TOTAL	0.02817	0.04324	0.02319	0.00799	0.00498	0.00013	0.00013	0.00000	0.10784

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00131

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-36

ANNUAL JOINT FREQUENCY OF WIND DIRECTION AND WIND SPEED FOR ALL STABILITY CLASSES CRBRP METEOROLOGICAL TOWER, 200-FOOT LEVEL JULY 1, 1973 THROUGH JUNE 30, 1974

WIND SPEED, KNOTS*

	0.0-1.3	1.4-2.9	3.0-4.7	4.8-6.4	6.5-10.0	10.1-16.0	16.1-21.0	21.1-99.0	Total
N	0.00448	0.00615	0.00419	0.00170	0.00195	0.00039	0.00013	0.00000	0.01899
NNE	0.00749	0.01048	0.00365	0.00313	0.00837	0.00091	0.00000	0.00000	0.03403
NE	0.00933	0.01467	0.01100	0.00877	0.00720	0.00183	0.00000	0.00000	0.05280
ENE	0.01156	0.03565	0.03040	0.02188	0.01376	0.00170	0.00000	0.00000	0.11495
E	0.01194	0.02607	0.01075	0.00590	0.00576	0.00065	0.00000	0.00000	0.06107
ESE	0.01378	0.01848	0.00682	0.00261	0.00261	0.00026	0.00000	0.00000	0.04456
SE	0.00853	0.00799	0.00380	0.00445	0.00288	0.00091	0.00013	0.00000	0.02869
SSE	0.00474	0.00485	0.00511	0.00208	0.00157	0.00130	0.00026	0.00000	0.01991
S	0.00618	0.00812	0.00721	0.00418	0.00262	0.00078	0.00000	0.00000	0.02909
SSW	0.01103	0.01573	0.01258	0.00995	0.01259	0.00916	0.001188	0.00052	0.07274
SW	0.01078	0.03433	0.02948	0.02319	0.03708	0.02947	0.00563	0.00197	0.17193
WSW	0.00949	0.01978	0.02464	0.01493	0.01991	0.00970	0.00222	0.00052	0.10119
W	0.00370	0.00904	0.00971	0.00497	0.00813	0.00433	0.00026	0.00013	0.04027
WNW	0.00541	0.00838	0.01075	0.01074	0.01796	0.00944	0.00104	0.00013	0.06385
NW	0.00736	0.01148	0.00944	0.01113	0.02568	0.01062	0.00039	0.00000	0.07610
NNW	0.01064	0.02266	0.00904	0.00497	0.00838	0.00396	0.00013	0.00000	0.05978
TOTAL	0.13644	0.25386	0.18857	0.13458	0.17645	0.08541	0.01137	0.00327	0.98995

THE TOTAL PERCENTAGE OF CALMS FOR THIS STABILITY IS: 0.00891

*1 knot = 0.515 m/sec; 1 knot = 1.16 mph

TABLE 2.6-37

PERCENT DISTRIBUTION OF THE PASQUILL STABILITY CLASSES A-G USING THE CRBRP ON-SITE DATA, 75 FOOT WIND LEVEL

	Stability Classes						
	A	B	C	D	E	F	G
January 1974	0.03537	0.08707	0.07075	0.52789	0.13061	0.05851	0.08980
Calm	0.0	0.0	0.00272	0.01905	0.01905	0.01633	0.04626
February 1974	0.00602	0.03759	0.04060	0.46315	0.20752	0.09775	0.14737
Calm	0.0	0.0	0.0	0.00150	0.02105	0.03008	0.08722
March 1974	0.18355	0.07489	0.04846	0.30543	0.16152	0.07342	0.15271
Calm	0.0	0.0	0.0	0.00881	0.01615	0.01615	0.03377
April 1974	0.15961	0.13029	0.01954	0.17590	0.14983	0.07817	0.28664
Calm	0.0	0.0	0.0	0.0	0.00651	0.03257	0.13029
May 1974	0.06052	0.09354	0.05227	0.26135	0.31361	0.13205	0.08665
Calm	0.0	0.0	0.0	0.00963	0.04814	0.04814	0.02063
June 1974	0.04590	0.11266	0.04729	0.27260	0.26426	0.17663	0.08066
Calm	0.0	0.0	0.0	0.00417	0.05146	0.09179	0.04033
July 1973	0.27648	0.02063	0.05915	0.17194	0.29298	0.14305	0.03576
Calm	0.0	0.0	0.00138	0.00963	0.03851	0.03301	0.00963
August 1973	0.24419	0.06478	0.03322	0.14618	0.17109	0.27575	0.06478
Calm	0.0	0.00166	0.0	0.00997	0.03488	0.12957	0.01993
September 1973	0.27378	0.04179	0.03026	0.17436	0.20461	0.22623	0.04899
Calm	0.0	0.0	0.00144	0.00865	0.04611	0.07349	0.01729
October 1973	0.14809	0.03526	0.02257	0.18476	0.28914	0.17208	0.14810
Calm	0.00423	0.0	0.00141	0.00987	0.03244	0.05642	0.05783
November 1973	0.05903	0.03757	0.04293	0.27549	0.28623	0.11986	0.17889
Calm	0.0	0.0	0.0	0.0	0.00179	0.02326	0.05546
December 1973	0.04283	0.04942	0.04778	0.45140	0.23229	0.08073	0.09555
Calm	0.0	0.0	0.0	0.00329	0.00494	0.00165	0.01153
Annual*	0.12714	0.06311	0.04436	0.28932	0.22917	0.13839	0.10851
Calm	0.00039	0.00013	0.00065	0.00763	0.02858	0.04669	0.03996

*July 1, 1973 through June 30, 1974

TABLE 2.6-38

PERCENTAGE DISTRIBUTION OF THE PASQUILL STABILITY CLASSES A-G USING THE CRBRP ON-SITE DATA, 200 FOOT WIND LEVEL

	Stability Classes						
	A	B	C	D	E	F	G
January 1974	0.03537	0.08707	0.06939	0.53061	0.13061	0.05850	0.08844
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
February 1974	0.00753	0.03765	0.04066	0.46836	0.20633	0.09639	0.14759
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.00151
March 1974	0.18209	0.07342	0.04846	0.30543	0.16153	0.07342	0.15565
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
April 1974	0.14384	0.12671	0.01712	0.18151	0.15411	0.07534	0.30137
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May 1974	0.06061	0.09366	0.05096	0.26033	0.31405	0.13223	0.08816
Calm	0.0	0.0	0.0	0.0	0.01377	0.01102	0.00138
June 1974	0.04590	0.11266	0.04729	0.27260	0.26425	0.17664	0.08067
Calm	0.0	0.0	0.0	0.0	0.02086	0.03060	0.00278
July 1973	0.27562	0.02078	0.05817	0.17036	0.29501	0.14404	0.03601
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
August 1973	0.24831	0.06588	0.03378	0.14865	0.16047	0.27703	0.06588
Calm	0.0	0.0	0.0	0.0	0.0	0.00169	0.00169
September 1973	0.27378	0.04179	0.03026	0.17435	0.20461	0.22622	0.04899
Calm	0.0	0.00144	0.0	0.0	0.0	0.0	0.0
October 1973	0.15272	0.03671	0.02496	0.17768	0.29809	0.17474	0.13510
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.00294
November 1973	0.06615	0.04086	0.04086	0.25486	0.29183	0.12062	0.18483
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.00584
December 1973	0.03922	0.04412	0.04575	0.46569	0.23039	0.08007	0.09477
Calm	0.0	0.0	0.0	0.0	0.00163	0.0	0.0
Annual*	0.12736	0.06302	0.04403	0.28996	0.22930	0.13849	0.10784
Calm	0.0	0.00013	0.0	0.0	0.00341	0.00406	0.00131

*July 1, 1973 through June 30, 1974

TABLE 2.6-39

ATMOSPHERIC DILUTION FACTORS
FOR 95 AND 50 PERCENT WEATHER

Distance (miles)	95 Percent χ/Q* (Pasquill G, 0.28 m/s)**	50 Percent χ/Q* (Pasquill D, 1.1 m/s)**
0.1	3.883×10^{-2}	1.091×10^{-3}
0.2	1.165×10^{-2}	4.809×10^{-4}
0.3	5.932×10^{-3}	2.907×10^{-4}
0.42+	3.436×10^{-3}	1.916×10^{-4}
0.5	2.600×10^{-3}	1.486×10^{-4}
0.7	1.921×10^{-3}	9.530×10^{-5}
1.0	1.309×10^{-3}	5.608×10^{-5}
2.0	6.120×10^{-4}	2.048×10^{-5}
3.0	3.955×10^{-4}	1.105×10^{-5}
5.0	2.229×10^{-4}	5.234×10^{-6}
10.0	1.049×10^{-4}	1.961×10^{-6}
20.0	4.869×10^{-5}	7.420×10^{-7}

*Includes building wake effect on χ/Q value

**Wind speed values are from the 75 foot level

+Minimum exclusion distance of 2,200 feet

TABLE 2.6-40

ATMOSPHERIC DILUTION FACTORS

χ/Q FOR ACCIDENT CONDITIONS

(sec/m^3)

Distance (miles)	Hours		Days	
	0-8*	8-24	1-4	4-30
0.1	9.872×10^{-3}	1.517×10^{-3}	1.413×10^{-3}	2.803×10^{-4}
0.2	2.978×10^{-3}	4.258×10^{-4}	4.007×10^{-4}	7.883×10^{-5}
0.3	1.530×10^{-3}	2.061×10^{-4}	1.916×10^{-4}	3.780×10^{-5}
0.42+	8.646×10^{-4}	1.156×10^{-4}	1.083×10^{-4}	1.670×10^{-5}
0.5	6.517×10^{-4}	8.475×10^{-5}	7.928×10^{-5}	1.536×10^{-5}
0.7	4.785×10^{-4}	4.801×10^{-5}	4.565×10^{-5}	8.796×10^{-6}
1.0	3.265×10^{-4}	2.663×10^{-5}	2.528×10^{-5}	4.846×10^{-6}
2.0	1.548×10^{-4}	8.665×10^{-6}	8.376×10^{-6}	1.594×10^{-6}
3.0	1.291×10^{-4}	4.582×10^{-6}	4.529×10^{-6}	8.593×10^{-7}
5.0	5.571×10^{-5}	2.091×10^{-6}	2.158×10^{-6}	4.078×10^{-7}
10.0	2.619×10^{-5}	7.269×10^{-7}	7.963×10^{-7}	1.500×10^{-7}
20.0	1.213×10^{-5}	2.669×10^{-7}	3.150×10^{-7}	5.966×10^{-8}

*Includes building wake factors given in Table 2.6-42

+Minimum exclusion distance of 2,200 feet

TABLE 2.6-41

SHORT-TERM METEOROLOGICAL DATA*

A. Maximum Hourly Wind Direction Persistence for Individual Stability Classes:

Type G	4 Hours
Type F	4 Hours
Type E	7 Hours
Type D	11 Hours
Type C	3 Hours
Type B	5 Hours
Type A	6 Hours

B. Maximum Frequency of Wind in any Sector:

Frequency	13.62% from Southwest

C. Maximum Hourly Persistence of Wind in Any Sector:

Duration	11 Hours from West-Northwest

D. Frequency Distribution of Stability Classes at the 75-foot Level Over Period of One Year (June 1, 1973 through June 30, 1974):

Type G	10.85%
Type F	13.84%
Type E	22.92%
Type D	28.93%
Type C	4.44%
Type B	6.31%
Type A	12.71%

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*Data collected at CRBRP meteorological tower during period July 1, 1973 through June 30, 1974.

TABLE 2.6-42

BUILDING WAKE EFFECT ON χ/Q VALUES

Downwind Distance (miles)	Reduction Factor For 50% Weather Value (Type D)	Reduction Factor for 95% Weather and 0-8 Hour Values (Type G)
0.1	0.33	0.33
0.2	0.50	0.33
0.3	0.64	0.33
0.42⁺	0.73	0.33
0.5	0.78	0.33
0.7	0.84	0.40
1.0	0.90	0.49
2.0	0.96	0.65
3.0	0.97	0.73
5.0	0.99	0.79
10.0	1.00	0.91
20.0	1.00	0.96

*Minimum exclusion distance of 2,200 feet

TABLE 2.6-43

SUMMARY OF ASSUMPTIONS FOR SHORT-TERM ACCIDENT, χ/Q ESTIMATES

Period	Pasquill Stability Class	Frequency Percent	Median Wind Speed (m/sec)*	Wind Condition	Joint Frequency Percent
0-8 Hours	Extremely Stable	50	0.79	Steady	50.0
	Very Stable	50	0.82		50.0
8-24 Hours	Moderately Stable	44	1.08	Uniformly Averaged Over 22.5° Sector With 100% Frequency	44.0
	Neutral	56	1.85		56.0
1-4 Days	Extremely Stable	15	0.79	Uniformly Averaged Over 22.5° Sector With 50% Frequency	7.5
	Very Stable	15	0.82		7.5
	Moderately Stable	27	1.08		13.5
	Neutral	42	1.85		21.0
4-30 Days	Extremely Stable	10	0.79	Uniformly Averaged Over 22.5° Sector With 14% Frequency	1.40
	Very Stable	10	0.82		1.40
	Moderately Stable	18	1.08		2.52
	Neutral	28	1.85		3.92
	Slightly Unstable	8	2.24		1.12
	Moderately Unstable	13	2.47		1.82
	Extremely Unstable	15	2.16		2.10

*Wind speed values are from the 75 foot level

TABLE 2.6-44

ESTIMATED ANNUAL AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 75 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	5.99E-7	1.06E-6	1.61E-6	1.16E-6	6.36E-7	8.14E-7	5.15E-7	3.67E-7	3.45E-7	6.33E-7	6.82E-7	1.05E-6	1.24E-6	8.54E-7	6.58E-7	5.03E-7
0.2	9.58E-7	1.23E-6	1.65E-6	1.05E-6	6.16E-7	9.43E-7	6.84E-7	6.61E-7	6.25E-7	1.10E-6	1.03E-6	1.46E-6	1.57E-6	1.20E-6	9.91E-7	6.89E-7
0.3	7.76E-7	9.43E-7	1.21E-6	7.61E-7	4.48E-7	6.94E-7	5.12E-7	5.25E-7	5.08E-7	8.77E-7	8.02E-7	1.14E-6	1.20E-6	9.34E-7	7.84E-7	5.53E-7
0.42*	7.18E-7	8.69E-7	1.11E-6	6.96E-7	4.10E-7	6.35E-7	4.70E-7	4.86E-7	4.71E-7	8.06E-7	7.35E-7	1.05E-6	1.10E-6	8.59E-7	7.22E-7	5.12E-7
0.5	4.87E-7	5.71E-7	6.88E-7	4.38E-7	2.60E-7	3.97E-7	3.00E-7	3.29E-7	3.22E-7	5.23E-7	4.66E-7	6.65E-7	6.97E-7	5.59E-7	4.74E-7	3.47E-7
0.8	2.91E-7	3.38E-7	3.81E-7	2.50E-7	1.50E-7	2.23E-7	1.73E-7	2.00E-7	1.96E-7	2.96E-7	2.57E-7	3.67E-7	3.91E-7	3.21E-7	2.74E-7	2.10E-7
1.0	2.22E-7	2.56E-7	2.81E-7	1.87E-7	1.13E-7	1.67E-7	1.30E-7	1.53E-7	1.50E-7	2.20E-7	1.90E-7	2.71E-7	2.91E-7	2.41E-7	2.06E-7	1.60E-7
1.5	1.31E-7	1.50E-7	1.60E-7	1.08E-7	6.56E-8	9.56E-8	7.55E-8	9.12E-8	8.94E-8	1.26E-7	1.08E-7	1.54E-7	1.66E-7	1.39E-7	1.20E-7	9.48E-8
2.5	6.56E-8	7.49E-8	7.75E-8	5.31E-8	3.23E-8	4.67E-8	3.72E-8	4.59E-8	4.50E-8	6.18E-8	5.23E-8	7.44E-8	8.11E-8	6.86E-8	5.92E-8	4.76E-8
3.5	4.12E-8	4.70E-8	4.80E-8	3.31E-8	2.02E-8	2.90E-8	2.32E-8	2.89E-8	2.84E-8	3.85E-8	3.24E-8	4.60E-8	5.03E-8	4.28E-8	3.70E-8	3.00E-8
4.5	2.92E-8	3.32E-8	3.36E-8	2.32E-8	1.42E-8	2.03E-8	1.63E-8	2.05E-8	2.01E-8	2.70E-8	2.26E-8	3.22E-8	3.53E-8	3.01E-8	2.60E-8	2.12E-8
7.5	1.45E-8	1.65E-8	1.64E-8	1.14E-8	7.00E-9	9.95E-9	8.03E-9	1.02E-8	1.00E-8	1.33E-8	1.10E-8	1.57E-8	1.73E-8	1.49E-8	1.29E-8	1.06E-8
10.0	9.86E-9	1.12E-8	1.10E-8	7.71E-9	4.72E-9	6.69E-9	5.42E-9	6.92E-9	6.82E-9	8.92E-9	7.40E-9	1.05E-8	1.16E-8	1.00E-8	8.68E-9	7.19E-9
15.0	5.54E-9	6.25E-9	6.14E-9	4.31E-9	2.64E-9	3.73E-9	3.02E-9	3.88E-9	3.83E-9	5.00E-9	4.14E-9	5.91E-9	6.49E-8	5.61E-9	4.87E-9	4.04E-9
20.0	3.90E-9	4.39E-9	4.24E-9	3.01E-9	1.85E-9	2.59E-9	2.11E-9	2.74E-9	2.70E-9	3.46E-9	2.85E-9	4.06E-9	4.50E-9	3.91E-9	3.40E-9	2.85E-9
25.0	2.97E-9	3.35E-9	3.20E-9	2.29E-9	1.40E-9	1.96E-9	1.60E-9	2.10E-9	2.07E-9	2.61E-9	2.14E-9	3.05E-9	3.39E-9	2.96E-9	2.58E-9	2.18E-9
30.0	2.39E-9	2.69E-9	2.54E-9	1.83E-9	1.13E-9	1.56E-9	1.28E-9	1.69E-9	1.67E-9	2.08E-9	1.70E-9	2.42E-9	2.70E-9	2.37E-9	2.06E-9	1.75E-9
35.0	1.98E-9	2.24E-9	2.09E-9	1.52E-9	9.33E-10	1.24E-9	1.06E-9	1.41E-9	1.39E-9	1.71E-9	1.39E-9	1.99E-9	2.23E-9	1.96E-9	1.71E-9	1.46E-9
40.0	1.69E-9	1.91E-9	1.77E-9	1.29E-9	7.94E-10	1.10E-9	9.05E-10	1.20E-9	1.18E-9	1.45E-9	1.18E-9	1.67E-9	1.88E-9	1.66E-9	1.45E-9	1.24E-9
45.0	1.47E-9	1.66E-9	1.53E-9	1.12E-9	6.89E-10	9.50E-10	7.85E-10	1.05E-9	1.03E-9	1.25E-9	1.01E-9	1.44E-9	1.63E-9	1.44E-9	1.26E-9	1.08E-9
50.0	1.30E-9	1.46E-9	1.34E-9	9.84E-10	6.07E-10	8.35E-10	6.91E-10	9.24E-10	4.10E-10	1.10E-9	8.88E-10	1.26E-9	1.43E-9	1.26E-9	1.11E-9	9.54E-10

*Site exclusion boundary

TABLE 2.6-45

ESTIMATED WINTER AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 75 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	5.85E-7	8.08E-7	1.46E-6	1.09E-6	5.45E-7	1.40E-6	8.41E-7	4.27E-7	5.36E-7	6.56E-7	4.78E-7	8.00E-7	1.16E-6	8.63E-7	5.23E-7	2.59E-7
0.2	8.32E-7	1.18E-6	1.70E-6	1.16E-6	6.03E-7	1.50E-6	9.86E-7	6.94E-7	7.97E-7	1.00E-6	7.86E-7	1.33E-6	1.63E-6	1.19E-6	7.39E-7	3.50E-7
0.3	6.33E-7	8.98E-7	1.22E-6	8.30E-7	4.23E-7	1.03E-6	6.89E-7	5.19E-7	6.00E-7	7.53E-7	5.93E-7	1.01E-6	1.21E-6	8.78E-7	5.52E-7	2.74E-7
0.5	3.76E-7	5.41E-7	6.83E-7	4.63E-7	2.48E-7	5.59E-7	3.84E-7	3.09E-7	3.69E-7	4.29E-7	3.49E-7	5.76E-7	6.87E-7	5.14E-7	3.30E-7	1.75E-7
0.8	2.18E-7	3.20E-7	3.75E-7	2.56E-7	1.50E-7	3.04E-7	2.17E-7	1.84E-7	2.27E-7	2.36E-7	2.01E-7	3.18E-7	3.79E-7	2.99E-7	1.96E-7	1.10E-7
1.0	1.64E-7	2.43E-7	2.78E-7	1.90E-7	1.16E-7	2.25E-7	1.62E-7	1.40E-7	1.76E-7	1.25E-7	1.52E-7	2.35E-7	2.81E-7	2.26E-7	1.49E-7	8.55E-8
1.5	9.57E-8	1.43E-7	1.58E-7	1.08E-7	6.91E-8	1.28E-7	9.39E-8	8.28E-8	1.06E-7	9.94E-8	8.87E-8	1.34E-7	1.60E-7	1.32E-7	8.87E-8	5.17E-8
2.5	4.73E-8	7.15E-8	7.63E-8	5.24E-8	3.48E-8	6.14E-8	4.59E-8	4.14E-8	5.34E-8	4.81E-8	4.38E-8	6.48E-8	7.73E-8	6.56E-8	4.40E-8	2.63E-8
3.5	2.96E-8	4.49E-8	4.71E-8	3.24E-8	2.19E-8	3.78E-8	2.85E-8	2.60E-8	3.37E-8	2.97E-8	2.74E-8	4.01E-8	4.78E-8	4.10E-8	2.76E-8	1.67E-8
4.5	2.08E-8	3.16E-8	3.29E-8	2.27E-8	1.55E-8	2.63E-8	2.00E-8	1.83E-8	2.39E-8	2.08E-8	1.92E-8	2.80E-8	3.34E-8	2.88E-8	1.95E-8	1.19E-8
7.5	1.03E-8	1.57E-8	1.60E-8	1.10E-8	7.69E-9	1.27E-8	9.75E-9	9.06E-9	1.19E-8	1.01E-8	9.47E-9	1.36E-8	1.62E-8	1.42E-8	9.65E-9	5.95E-9
10.0	6.93E-9	1.06E-8	1.07E-8	7.40E-9	5.21E-9	8.50E-9	6.55E-9	6.12E-9	8.08E-9	6.76E-9	6.38E-9	9.12E-9	1.09E-8	9.59E-9	6.53E-9	4.06E-9
15.0	3.87E-9	5.93E-9	5.95E-9	4.11E-9	2.90E-9	4.70E-9	3.62E-9	3.41E-9	4.52E-9	3.76E-9	3.56E-9	5.08E-9	6.05E-9	5.34E-9	3.64E-9	2.28E-9
20.0	2.71E-9	4.17E-9	4.11E-9	2.85E-9	2.06E-9	3.25E-9	2.53E-9	2.40E-9	3.21E-9	2.59E-9	2.49E-9	3.50E-9	4.18E-9	3.74E-9	2.57E-9	1.62E-9
25.0	2.06E-9	3.18E-9	3.10E-9	2.15E-9	1.58E-9	2.45E-9	1.92E-9	1.83E-9	2.46E-9	1.95E-9	1.89E-9	2.63E-9	3.14E-9	2.85E-9	1.96E-9	1.25E-9
30.0	1.65E-9	2.56E-9	2.46E-9	1.72E-9	1.28E-9	1.95E-9	1.54E-9	1.47E-9	1.99E-9	1.55E-9	1.51E-9	2.09E-9	2.49E-9	2.29E-9	1.58E-9	1.01E-9
35.0	1.37E-9	2.13E-9	2.03E-9	1.42E-9	1.07E-9	1.61E-9	1.27E-9	1.23E-9	1.66E-9	1.27E-9	1.25E-9	1.72E-9	2.05E-9	1.90E-9	1.31E-9	8.45E-10
40.0	1.16E-9	1.81E-9	1.72E-9	1.20E-9	9.15E-10	1.36E-9	1.08E-9	1.05E-9	1.42E-9	1.07E-9	1.07E-9	1.45E-9	1.74E-9	1.62E-9	1.12E-9	7.25E-10
45.0	1.01E-9	1.58E-9	1.48E-9	1.04E-9	7.99E-10	1.18E-9	9.40E-10	9.11E-10	1.24E-9	9.27E-10	9.25E-10	1.25E-9	1.50E-9	1.40E-9	9.75E-10	6.32E-10
50.0	8.90E-10	1.39E-9	1.30E-9	9.13E-10	7.07E-10	1.03E-9	8.28E-10	8.05E-10	1.10E-9	8.13E-10	8.15E-10	1.10E-9	1.32E-9	1.24E-9	8.61E-10	5.60E-10

TABLE 2.6-46

ESTIMATED SPRING AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 75 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	2.93E-7	7.86E-7	1.71E-6	9.55E-7	4.20E-7	6.21E-7	4.95E-7	7.50E-7	2.17E-7	4.29E-7	6.07E-7	9.80E-7	6.86E-7	5.69E-7	2.74E-7	2.88E-7
0.2	5.89E-7	7.87E-7	1.75E-6	9.61E-7	4.67E-7	7.08E-7	7.26E-7	1.22E-6	5.57E-7	7.14E-7	9.61E-7	1.19E-6	1.02E-6	7.62E-7	5.38E-7	5.17E-7
0.3	5.00E-7	5.96E-7	1.27E-6	7.08E-7	3.40E-7	5.18E-7	5.56E-7	9.57E-7	4.73E-7	5.46E-7	7.41E-7	9.05E-7	7.48E-7	6.04E-7	4.53E-7	4.40E-7
0.5	3.59E-7	4.06E-7	7.40E-7	4.31E-7	1.98E-7	2.99E-7	3.31E-7	6.27E-7	3.04E-7	3.21E-7	4.27E-7	5.44E-7	4.95E-7	3.98E-7	3.07E-7	3.16E-7
0.8	2.47E-7	2.78E-7	4.28E-7	2.62E-7	1.15E-7	1.71E-7	1.91E-7	4.05E-7	1.84E-7	1.83E-7	2.35E-7	3.19E-7	2.97E-7	2.57E-7	1.98E-7	2.17E-7
1.0	1.97E-7	2.22E-7	3.22E-7	2.01E-7	8.67E-8	1.28E-7	1.44E-7	3.17E-7	1.40E-7	1.37E-7	1.73E-7	2.41E-7	2.27E-7	2.01E-7	1.55E-7	1.73E-7
1.5	1.24E-7	1.39E-7	1.88E-7	1.20E-7	5.06E-8	7.41E-8	8.38E-8	1.94E-7	8.33E-8	7.96E-8	9.83E-8	1.41E-7	1.35E-7	1.23E-7	9.48E-8	1.08E-7
2.5	6.46E-8	7.25E-8	9.27E-8	6.04E-8	2.50E-8	3.64E-8	4.14E-8	9.97E-8	4.19E-8	3.91E-8	4.75E-8	7.00E-8	6.75E-8	6.31E-8	4.87E-8	5.65E-8
3.5	4.14E-8	4.64E-8	5.79E-8	3.81E-8	1.57E-8	2.27E-8	2.59E-8	6.34E-8	2.64E-8	2.44E-8	2.94E-8	4.39E-8	4.25E-8	4.01E-8	3.10E-8	3.62E-8
4.5	2.96E-8	3.32E-8	4.07E-8	2.70E-8	1.10E-8	1.59E-8	1.82E-8	4.51E-8	1.87E-8	1.71E-8	2.05E-8	3.09E-8	3.00E-8	2.86E-8	2.21E-8	2.59E-8
7.5	1.51E-8	1.69E-8	2.01E-8	1.35E-8	5.43E-9	7.83E-9	8.98E-9	2.27E-8	9.33E-9	8.41E-9	9.99E-9	1.53E-8	1.50E-8	1.44E-8	1.12E-8	1.32E-8
10.0	1.03E-8	1.16E-8	1.36E-8	9.15E-9	3.67E-9	5.27E-9	6.06E-9	1.55E-8	6.33E-9	5.66E-9	6.69E-9	1.04E-8	1.01E-8	9.83E-9	7.62E-9	9.04E-9
15.0	5.82E-9	6.50E-9	7.58E-9	5.12E-9	2.05E-9	2.94E-9	3.39E-9	8.69E-9	3.56E-9	3.16E-9	3.74E-9	5.80E-9	5.69E-9	5.52E-9	4.29E-9	5.09E-9
20.0	4.19E-9	4.69E-9	5.31E-9	3.63E-9	1.44E-9	2.06E-9	2.37E-9	6.21E-9	2.51E-9	2.20E-9	2.57E-9	4.07E-9	4.01E-9	3.95E-9	3.06E-9	3.67E-9
25.0	3.25E-9	3.65E-9	4.05E-9	2.79E-9	1.09E-9	1.56E-9	1.80E-9	4.80E-9	1.92E-9	1.66E-9	1.93E-9	3.10E-9	3.07E-9	3.05E-9	2.36E-9	2.85E-9
30.0	2.65E-9	2.97E-9	3.24E-9	2.25E-9	8.77E-10	1.25E-9	1.44E-9	3.89E-9	1.54E-9	1.33E-9	1.53E-9	2.49E-9	2.47E-9	2.47E-9	1.91E-9	2.32E-9
35.0	2.23E-9	2.50E-9	2.69E-9	1.88E-9	7.28E-10	1.04E-9	1.19E-9	2.26E-9	1.28E-9	1.10E-9	1.25E-9	2.06E-9	2.05E-9	2.07E-9	1.60E-9	1.95E-9
40.0	1.92E-9	2.16E-9	2.29E-9	1.61E-9	6.20E-10	8.81E-10	1.01E-9	2.80E-9	1.09E-9	9.33E-10	1.06E-9	1.76E-9	1.75E-9	1.78E-9	1.37E-9	1.68E-9
45.0	1.68E-9	1.89E-9	1.99E-9	1.40E-9	5.39E-10	7.64E-10	8.80E-10	2.45E-9	9.48E-10	8.08E-10	9.12E-10	1.53E-9	1.53E-9	1.55E-9	1.20E-9	1.47E-9
50.0	1.49E-9	1.68E-9	1.76E-9	1.24E-9	4.75E-10	6.73E-10	7.75E-10	2.17E-9	8.37E-10	7.11E-10	7.98E-10	1.35E-9	1.35E-9	1.38E-9	1.06E-9	1.30E-9

TABLE 2.6-47

ESTIMATED SUMMER AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 75 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	1.02E-6	1.90E-6	2.18E-6	1.90E-6	1.08E-6	6.57E-7	3.09E-7	7.09E-7	2.92E-7	1.15E-6	9.01E-7	1.70E-6	1.52E-6	1.06E-6	9.68E-7	8.69E-7
0.2	1.47E-6	2.07E-6	1.90E-6	1.10E-6	8.14E-7	7.30E-7	4.55E-7	2.20E-7	4.28E-7	1.79E-6	1.25E-6	1.70E-6	1.66E-6	1.58E-6	1.44E-6	1.06E-6
0.3	1.18E-6	1.53E-6	1.39E-6	7.32E-7	5.88E-7	5.78E-7	3.59E-7	1.91E-7	3.46E-7	1.41E-6	9.91E-7	1.29E-6	1.27E-6	1.27E-6	1.14E-6	8.26E-7
0.5	6.97E-7	8.62E-7	7.83E-7	3.86E-7	3.28E-7	3.39E-7	2.10E-7	1.17E-7	2.13E-7	8.04E-7	5.71E-7	7.29E-7	7.25E-7	7.30E-7	6.45E-7	4.73E-7
0.8	3.84E-7	4.60E-7	4.29E-7	2.04E-7	1.78E-7	1.86E-7	1.15E-7	6.53E-8	1.24E-7	4.26E-7	3.07E-7	3.87E-7	3.92E-7	3.82E-7	3.35E-7	2.53E-7
1.0	2.82E-7	3.34E-7	3.14E-7	1.47E-7	1.29E-7	1.36E-7	8.43E-8	4.82E-8	9.31E-8	3.08E-7	2.24E-7	2.80E-7	2.86E-7	2.75E-7	2.40E-7	1.84E-7
1.5	1.59E-7	1.85E-7	1.77E-7	8.05E-8	7.21E-8	7.65E-8	4.75E-8	2.73E-8	5.43E-8	1.70E-7	1.25E-7	1.54E-7	1.60E-7	1.51E-7	1.31E-7	1.02E-7
2.5	7.67E-8	8.74E-8	8.49E-8	3.79E-8	3.44E-8	3.68E-8	2.29E-8	1.33E-8	2.69E-8	8.05E-8	5.95E-8	7.30E-8	7.62E-8	7.10E-8	6.10E-8	4.85E-8
3.5	4.75E-8	5.39E-8	5.24E-8	2.31E-8	2.12E-8	2.28E-8	1.41E-8	8.23E-9	1.68E-8	4.93E-8	3.66E-8	4.47E-8	4.69E-8	4.34E-8	3.72E-8	2.98E-8
4.5	3.32E-8	3.75E-8	3.66E-8	1.60E-8	1.48E-8	1.59E-8	9.87E-9	5.77E-9	1.19E-8	3.42E-8	2.55E-8	3.11E-8	3.27E-8	3.01E-8	2.58E-8	2.08E-8
7.5	1.62E-8	1.81E-8	1.78E-8	7.71E-9	7.18E-9	7.77E-9	4.80E-9	2.83E-9	5.88E-9	1.65E-8	1.24E-8	1.50E-8	1.59E-8	1.45E-8	1.23E-8	1.08E-8
10.0	1.09E-8	1.21E-8	1.19E-8	5.13E-9	4.80E-9	5.21E-9	3.22E-9	1.90E-9	3.98E-9	1.10E-8	8.25E-9	1.00E-8	1.06E-8	9.64E-9	8.16E-9	6.70E-9
15.0	6.11E-9	6.77E-9	6.67E-9	2.86E-9	2.68E-9	2.93E-9	1.80E-9	1.07E-9	2.24E-9	6.14E-9	4.63E-9	5.61E-9	5.94E-9	5.42E-9	4.57E-9	3.76E-9
20.0	4.19E-9	4.68E-9	4.59E-9	1.95E-9	1.84E-9	2.01E-9	1.24E-9	7.37E-10	1.56E-9	4.15E-9	3.15E-9	3.80E-9	4.06E-9	3.65E-9	3.06E-9	2.56E-9
25.0	3.14E-9	3.42E-9	3.44E-9	1.45E-9	1.37E-9	1.50E-9	9.25E-10	5.52E-10	1.19E-9	3.07E-9	2.34E-9	2.82E-9	3.02E-9	2.69E-9	2.24E-9	1.90E-9
30.0	2.48E-9	2.69E-9	2.72E-9	1.14E-9	1.08E-9	1.19E-9	7.31E-10	4.36E-10	9.50E-10	2.40E-9	1.84E-9	2.21E-9	2.38E-9	2.09E-9	1.74E-9	1.49E-9
35.0	2.04E-9	2.19E-9	2.24E-9	9.33E-10	8.88E-10	9.72E-10	5.99E-10	3.58E-10	7.87E-10	1.95E-9	1.50E-9	1.80E-9	1.95E-9	1.70E-9	1.41E-9	1.22E-9
40.0	1.71E-9	1.84E-9	1.89E-9	7.84E-10	7.48E-10	8.19E-10	5.05E-10	3.01E-10	6.69E-10	1.63E-9	1.26E-9	1.51E-9	1.64E-9	1.41E-9	1.17E-9	1.02E-9
45.0	1.48E-9	1.58E-9	1.63E-9	6.73E-10	6.43E-10	7.04E-10	4.34E-10	2.59E-10	5.80E-10	1.39E-9	1.08E-9	1.29E-9	1.41E-9	1.21E-9	9.94E-10	8.75E-10
50.0	1.29E-9	1.37E-9	1.42E-9	5.87E-10	5.62E-10	6.15E-10	3.79E-10	2.27E-10	5.10E-10	1.21E-9	9.41E-10	1.12E-9	1.23E-9	1.04E-9	8.59E-10	7.62E-10

TABLE 2.6-48

ESTIMATED FALL AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 75 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	6.97E-7	1.09E-6	1.26E-6	9.32E-7	5.12E-7	5.39E-7	3.37E-7	5.36E-7	3.43E-7	5.34E-7	8.51E-7	1.03E-6	1.87E-6	1.18E-6	9.90E-7	7.70E-7
0.2	1.13E-6	1.17E-6	1.26E-6	8.21E-7	4.42E-7	7.10E-7	4.09E-7	1.57E-7	5.56E-7	1.20E-6	1.28E-6	1.65E-6	2.15E-6	1.53E-6	1.41E-6	9.94E-7
0.3	9.27E-7	8.99E-7	9.42E-7	6.12E-7	3.37E-7	5.57E-7	3.16E-7	1.39E-7	4.62E-7	1.01E-6	1.01E-6	1.34E-6	1.62E-6	1.19E-6	1.12E-6	7.90E-7
0.5	5.89E-7	5.47E-7	5.38E-7	3.76E-7	2.11E-7	3.46E-7	1.96E-7	9.63E-8	3.12E-7	6.49E-7	5.87E-7	7.93E-7	9.33E-7	6.99E-7	6.76E-7	4.91E-7
0.8	3.56E-7	3.25E-7	2.96E-7	2.30E-7	1.30E-7	2.08E-7	1.19E-7	6.25E-8	2.01E-7	3.91E-7	3.23E-7	4.40E-7	5.20E-7	3.91E-7	3.91E-7	2.92E-7
1.0	2.72E-7	2.46E-7	2.17E-7	1.76E-7	9.98E-8	1.58E-7	9.14E-8	4.89E-8	1.57E-7	2.98E-7	2.38E-7	3.24E-7	3.85E-7	2.89E-7	2.94E-7	2.22E-7
1.5	1.61E-7	1.45E-7	1.23E-7	1.05E-7	5.96E-8	9.38E-8	5.44E-8	2.99E-8	9.60E-8	1.76E-7	1.35E-7	1.84E-7	2.20E-7	1.65E-7	1.71E-7	1.31E-7
2.5	8.10E-8	7.21E-8	5.93E-8	5.27E-8	3.01E-8	4.70E-8	2.74E-8	1.54E-8	4.93E-8	8.85E-8	6.52E-8	8.90E-8	1.07E-7	8.01E-8	8.42E-8	6.53E-8
3.5	5.11E-8	4.53E-8	3.66E-8	3.33E-8	1.90E-8	2.96E-8	1.73E-8	9.80E-9	3.14E-8	5.57E-8	4.03E-8	5.52E-8	6.62E-8	4.97E-8	5.27E-8	4.11E-8
4.5	3.62E-8	3.20E-8	2.56E-8	2.36E-8	1.35E-8	2.09E-8	1.22E-8	6.98E-9	2.24E-8	3.94E-8	2.82E-8	3.86E-8	4.63E-8	3.49E-8	3.71E-8	2.90E-8
7.5	1.80E-8	1.59E-8	1.25E-8	1.18E-8	6.77E-9	1.04E-8	6.11E-9	3.53E-9	1.13E-8	1.97E-8	1.38E-8	1.89E-8	2.27E-8	1.71E-8	1.83E-8	1.44E-8
10.0	1.22E-8	1.08E-8	8.37E-9	8.00E-9	4.60E-9	7.07E-9	4.15E-9	2.41E-9	7.72E-9	1.34E-8	9.22E-9	1.27E-8	1.52E-8	1.15E-8	1.24E-8	9.79E-9
15.0	6.89E-9	6.04E-9	4.69E-9	4.49E-9	2.59E-9	3.97E-9	2.33E-9	1.36E-9	4.35E-9	7.52E-9	5.16E-9	7.12E-9	8.50E-9	6.42E-9	6.94E-9	5.50E-9
20.0	4.86E-9	4.25E-9	3.22E-9	3.18E-9	1.83E-9	2.80E-9	1.64E-9	9.70E-10	3.10E-9	5.29E-9	3.55E-9	4.90E-9	5.88E-9	4.43E-9	4.85E-9	3.87E-9
25.0	3.71E-9	3.24E-9	2.42E-9	2.44E-9	1.41E-9	2.14E-9	1.26E-9	7.48E-10	2.39E-9	4.03E-9	2.66E-9	3.67E-9	4.43E-9	3.34E-9	3.68E-9	2.95E-9
30.0	2.98E-9	2.60E-9	1.92E-9	1.97E-9	1.14E-9	1.72E-9	1.02E-9	6.05E-10	1.94E-9	3.24E-9	2.11E-9	2.91E-9	3.52E-9	2.65E-9	2.94E-9	2.37E-9
35.0	2.48E-9	2.16E-9	1.58E-9	1.64E-9	9.47E-10	1.43E-9	8.46E-10	5.06E-10	1.62E-9	2.69E-9	1.73E-9	2.39E-9	2.90E-9	2.18E-9	2.43E-9	1.97E-9
40.0	2.12E-9	1.84E-9	1.33E-9	1.40E-9	8.10E-10	1.22E-9	7.23E-10	4.34E-10	1.39E-9	2.29E-9	1.46E-9	2.01E-9	2.46E-9	1.84E-9	2.07E-9	1.68E-9
45.0	1.84E-9	1.60E-9	1.15E-9	1.22E-9	7.06E-10	1.06E-9	6.30E-10	3.79E-10	1.22E-9	1.99E-9	1.26E-9	1.73E-9	2.12E-9	1.59E-9	1.79E-9	1.46E-9
50.0	1.62E-9	1.41E-9	1.00E-9	1.08E-9	6.24E-10	9.39E-10	5.57E-10	3.36E-10	1.08E-9	1.76E-9	1.10E-9	1.52E-9	1.86E-9	1.39E-9	1.58E-9	1.29E-9

TABLE 2.6-49

ESTIMATED ANNUAL AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 200 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	3.88E-7	7.02E-7	1.31E-6	8.37E-7	4.12E-7	5.45E-7	6.12E-7	6.09E-7	1.82E-7	3.40E-7	4.32E-7	1.02E-6	6.67E-7	5.01E-7	2.91E-7	2.45E-7
0.2	4.44E-7	8.47E-7	1.66E-6	9.74E-7	4.43E-7	6.21E-7	7.82E-7	9.84E-7	3.47E-7	5.54E-7	7.23E-7	1.53E-6	1.07E-6	8.59E-7	4.50E-7	2.95E-7
0.3	3.32E-7	6.51E-7	1.28E-6	7.41E-7	3.25E-7	4.51E-7	5.78E-7	7.75E-7	2.81E-7	4.39E-7	5.84E-7	1.21E-6	8.59E-7	6.97E-7	3.60E-7	2.26E-7
0.42*	3.04E-7	5.98E-7	1.18E-6	6.84E-7	2.98E-7	4.11E-7	5.28E-7	7.12E-7	2.57E-7	4.03E-7	5.42E-7	1.12E-6	7.90E-7	6.43E-7	3.32E-7	2.07E-7
0.5	1.92E-7	3.85E-7	7.77E-7	4.56E-7	1.91E-7	2.51E-7	3.27E-7	4.60E-7	1.63E-7	2.57E-7	3.57E-7	7.33E-7	5.15E-7	4.25E-7	2.20E-7	1.32E-7
0.8	1.08E-7	2.19E-7	4.57E-7	2.77E-7	1.11E-7	1.37E-7	1.80E-7	2.60E-7	8.77E-8	1.41E-7	2.07E-7	4.25E-7	2.92E-7	2.44E-7	1.28E-7	7.30E-8
1.0	8.01E-8	1.64E-7	3.46E-7	2.12E-7	8.37E-8	1.01E-7	1.33E-7	1.94E-7	6.39E-8	1.04E-7	1.55E-7	3.20E-7	2.17E-7	1.83E-7	9.62E-8	5.40E-8
1.5	4.59E-8	9.45E-8	2.03E-7	1.26E-7	4.89E-8	5.68E-8	7.57E-8	1.11E-7	3.57E-8	5.85E-8	9.03E-8	1.86E-7	1.25E-7	1.06E-7	5.60E-8	3.07E-8
2.5	2.23E-8	4.64E-8	1.01E-7	6.35E-8	2.42E-8	2.73E-8	3.66E-8	5.45E-8	1.70E-8	2.82E-8	4.46E-8	9.22E-8	6.10E-8	5.22E-8	2.77E-8	1.49E-8
3.5	1.39E-8	2.89E-8	6.33E-8	4.00E-8	1.52E-8	1.69E-8	2.26E-8	3.39E-8	1.05E-8	1.74E-8	2.79E-8	5.77E-8	3.80E-8	3.26E-8	1.74E-8	9.23E-9
4.5	9.73E-9	2.03E-8	4.46E-8	2.83E-8	1.07E-8	1.18E-8	1.58E-8	2.38E-8	7.30E-9	1.22E-8	1.97E-8	4.06E-8	2.67E-8	2.29E-8	1.22E-8	6.46E-9
7.5	4.77E-9	1.00E-8	2.21E-8	1.41E-8	5.27E-9	5.70E-9	7.69E-9	1.17E-8	3.53E-9	5.94E-9	9.72E-9	2.01E-8	1.31E-8	1.13E-8	6.05E-9	3.16E-9
10.0	3.20E-9	6.75E-9	1.49E-8	9.59E-9	3.56E-9	3.81E-9	5.15E-9	7.86E-9	2.36E-9	3.98E-9	6.56E-9	1.36E-8	8.84E-9	7.64E-9	4.09E-9	2.12E-9
15.0	1.79E-9	3.78E-9	8.40E-9	5.38E-9	1.99E-9	2.12E-9	2.87E-9	4.40E-9	1.33E-9	2.23E-9	3.69E-9	7.61E-9	4.96E-9	4.29E-9	2.30E-9	1.19E-9
20.0	1.24E-9	2.63E-9	5.90E-9	3.81E-9	1.40E-9	1.46E-9	1.98E-9	3.05E-9	8.99E-10	1.53E-9	2.57E-9	5.32E-9	3.44E-9	2.99E-9	1.60E-9	8.20E-10
25.0	9.37E-10	1.99E-9	4.50E-9	2.92E-9	1.07E-9	1.09E-9	1.49E-9	2.30E-9	6.68E-10	1.15E-9	1.95E-9	4.04E-9	2.59E-9	2.26E-9	1.22E-9	6.18E-10
30.0	7.47E-10	1.59E-9	3.61E-9	2.35E-9	8.55E-10	8.67E-10	1.18E-9	1.83E-9	5.25E-10	9.06E-10	1.56E-9	3.23E-9	2.06E-9	1.80E-9	9.74E-10	4.90E-10
35.0	6.17E-10	1.32E-9	3.00E-9	1.96E-9	7.11E-10	7.13E-10	9.75E-10	1.51E-9	4.29E-10	7.43E-10	1.29E-9	2.68E-9	1.70E-9	1.49E-9	8.07E-10	4.03E-10
40.0	5.23E-10	1.12E-9	2.56E-9	1.67E-9	6.06E-10	6.02E-10	8.25E-10	1.28E-9	3.59E-10	6.27E-10	1.10E-9	2.28E-9	1.44E-9	1.27E-9	6.86E-10	3.41E-10
45.0	4.52E-10	9.67E-10	2.22E-9	1.46E-9	5.26E-10	5.19E-10	7.12E-10	1.11E-9	3.08E-10	5.39E-10	9.50E-10	1.97E-9	1.25E-9	1.10E-9	5.95E-10	2.95E-10
50.0	3.97E-10	8.50E-10	1.96E-9	1.29E-9	4.64E-10	4.54E-10	6.25E-10	9.73E-10	2.68E-10	4.71E-10	8.36E-10	1.74E-9	1.09E-9	9.63E-10	5.23E-10	2.58E-10

*Site exclusion boundary

TABLE 2.6-50

ESTIMATED WINTER AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 200 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	2.70E-7	4.92E-7	1.26E-6	8.96E-7	5.38E-7	8.68E-7	1.17E-6	7.49E-7	1.73E-7	1.88E-7	3.18E-7	9.65E-7	6.61E-7	3.74E-7	2.92E-7	2.11E-7
0.2	3.91E-7	6.22E-7	1.45E-6	9.53E-7	5.51E-7	1.05E-6	1.32E-6	1.08E-6	2.62E-7	2.51E-7	5.70E-7	1.44E-6	1.07E-6	6.53E-7	4.70E-7	2.45E-7
0.3	2.94E-7	4.56E-7	1.05E-6	6.77E-7	3.43E-7	7.37E-7	9.10E-7	7.99E-7	1.95E-7	1.83E-7	4.45E-7	1.08E-6	8.19E-7	5.09E-7	3.57E-7	1.77E-7
0.5	1.71E-7	2.51E-7	6.29E-7	3.98E-7	2.29E-7	3.94E-7	4.82E-7	4.63E-7	1.07E-7	1.02E-7	2.68E-7	6.36E-7	4.86E-7	3.10E-7	2.05E-7	9.37E-8
0.8	9.63E-8	1.34E-7	3.78E-7	2.38E-7	1.35E-7	2.07E-7	2.54E-7	2.65E-7	5.62E-8	5.54E-8	1.57E-7	3.72E-7	2.81E-7	1.83E-7	1.13E-7	4.66E-8
1.0	7.19E-8	9.76E-8	2.90E-7	1.82E-7	1.03E-7	1.51E-7	1.85E-7	1.99E-7	4.07E-8	4.08E-8	1.19E-7	2.81E-7	2.12E-7	1.39E-7	8.37E-8	3.30E-8
1.5	4.14E-8	5.44E-8	1.73E-7	1.08E-7	6.04E-8	8.40E-8	1.03E-7	1.16E-7	2.25E-8	2.31E-8	6.96E-8	1.65E-7	1.23E-7	8.20E-8	4.76E-8	1.76E-8
2.5	2.03E-8	2.59E-8	8.66E-8	5.40E-8	3.00E-8	3.97E-8	4.88E-8	5.70E-8	1.06E-8	1.11E-8	3.46E-8	8.19E-8	6.09E-8	4.09E-8	2.30E-8	8.04E-9
3.5	1.26E-8	1.59E-8	5.45E-8	3.39E-8	1.88E-8	2.43E-8	2.98E-8	3.55E-8	6.45E-9	6.82E-9	2.16E-8	5.12E-8	3.81E-8	2.56E-8	1.43E-8	4.83E-9
4.5	8.85E-9	1.10E-8	3.85E-8	2.39E-8	1.33E-8	1.68E-8	2.06E-8	2.50E-8	4.47E-9	4.75E-9	1.53E-8	3.61E-8	2.68E-8	1.81E-8	9.97E-9	3.31E-9
7.5	4.33E-9	5.30E-9	1.91E-8	1.19E-8	6.57E-9	8.02E-9	9.86E-9	1.23E-8	2.13E-9	2.30E-9	7.54E-9	1.78E-8	1.32E-8	8.96E-9	4.85E-9	1.55E-9
10.0	2.91E-9	3.53E-9	1.30E-8	8.04E-9	4.44E-9	5.32E-9	6.53E-9	8.25E-9	1.41E-9	1.54E-9	5.09E-9	1.20E-8	8.90E-9	6.06E-9	3.25E-9	1.01E-9
15.0	1.63E-9	1.96E-9	7.25E-9	4.49E-9	2.48E-9	2.93E-9	3.59E-9	4.59E-9	7.83E-10	8.52E-10	2.85E-9	6.70E-9	4.97E-9	3.39E-9	1.81E-9	5.60E-10
20.0	1.13E-9	1.34E-9	5.13E-9	3.18E-9	1.75E-9	2.00E-9	2.45E-9	3.21E-9	5.29E-10	5.86E-10	2.00E-9	4.70E-9	3.47E-9	2.38E-9	1.25E-9	3.69E-10
25.0	8.55E-10	9.96E-10	3.94E-9	2.44E-9	1.34E-9	1.49E-9	1.83E-9	2.44E-9	3.91E-10	4.40E-10	1.52E-9	3.58E-9	2.64E-9	1.82E-9	9.38E-10	2.68E-10
30.0	6.81E-10	7.85E-10	3.18E-9	1.97E-9	1.08E-9	1.17E-9	1.44E-9	1.95E-9	3.06E-10	3.48E-10	1.22E-9	2.87E-9	2.11E-9	1.46E-9	7.44E-10	2.06E-10
35.0	5.63E-10	6.42E-10	2.66E-9	1.64E-9	8.98E-10	9.57E-10	1.18E-9	1.61E-9	2.49E-10	2.86E-10	1.01E-9	2.39E-9	1.75E-9	1.21E-9	6.12E-10	1.65E-10
40.0	4.78E-10	5.40E-10	2.27E-9	1.41E-9	7.67E-10	8.05E-10	9.96E-10	1.37E-9	2.08E-10	2.42E-10	8.59E-10	2.04E-9	1.49E-9	1.03E-9	5.17E-10	1.36E-10
45.0	4.14E-10	4.64E-10	1.98E-9	1.23E-9	6.68E-10	6.92E-10	8.57E-10	1.19E-9	1.78E-10	2.09E-10	7.46E-10	1.77E-9	1.29E-9	8.97E-10	4.46E-10	1.15E-10
50.0	3.64E-10	4.05E-10	1.75E-9	1.09E-9	5.90E-10	6.04E-10	7.49E-10	1.05E-9	1.54E-10	1.83E-10	6.57E-10	1.56E-9	1.13E-9	7.91E-10	3.91E-10	9.90E-11

TABLE 2.6-51

ESTIMATED SPRING AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 200 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	3.74E-7	5.03E-7	1.26E-6	6.41E-7	4.18E-7	4.21E-7	4.49E-7	3.49E-7	1.70E-7	2.79E-7	3.12E-7	1.08E-6	4.12E-7	4.34E-7	2.43E-7	1.58E-7
0.2	4.03E-7	5.89E-7	1.44E-6	7.15E-7	4.26E-7	4.86E-7	5.46E-7	6.07E-7	2.74E-7	4.14E-7	5.96E-7	1.18E-6	8.30E-7	6.83E-7	3.49E-7	2.38E-7
0.3	2.99E-7	4.56E-7	1.08E-6	5.51E-7	3.04E-7	3.62E-7	4.14E-7	4.83E-7	2.12E-7	3.28E-7	4.82E-7	8.88E-7	6.94E-7	5.62E-7	2.84E-7	1.95E-7
0.5	1.62E-7	2.94E-7	6.65E-7	3.75E-7	1.74E-7	2.24E-7	2.41E-7	3.06E-7	1.25E-7	2.07E-7	3.05E-7	5.73E-7	4.40E-7	3.77E-7	1.84E-7	1.29E-7
0.8	8.27E-8	1.88E-7	4.07E-7	2.55E-7	1.06E-7	1.39E-7	1.36E-7	1.89E-7	7.19E-8	1.26E-7	1.86E-7	3.71E-7	2.64E-7	2.43E-7	1.15E-7	8.26E-8
1.0	5.89E-8	1.46E-7	3.13E-7	2.02E-7	7.58E-8	1.07E-7	1.01E-7	1.46E-7	5.39E-8	9.66E-8	1.42E-7	2.91E-7	2.01E-7	1.90E-7	8.85E-8	6.43E-8
1.5	3.18E-8	8.89E-8	1.87E-7	1.26E-7	4.42E-8	6.46E-8	5.80E-8	8.75E-8	3.13E-8	5.76E-8	8.49E-8	1.78E-7	1.18E-7	1.16E-7	5.32E-8	3.91E-8
2.5	1.47E-8	4.55E-8	9.47E-8	6.57E-8	2.19E-8	3.28E-8	2.83E-8	4.43E-8	1.54E-8	2.90E-8	4.28E-8	9.17E-8	5.93E-8	5.95E-8	2.70E-8	2.00E-8
3.5	8.90E-9	2.89E-8	5.98E-8	4.20E-8	1.36E-8	2.07E-8	1.76E-8	2.80E-8	9.60E-9	1.83E-8	2.70E-8	5.84E-8	3.73E-8	3.79E-8	1.71E-8	1.27E-8
4.5	6.14E-9	2.06E-8	4.23E-8	3.00E-8	9.60E-9	1.47E-8	1.24E-8	1.98E-8	6.75E-9	1.30E-8	1.91E-8	4.15E-8	2.64E-8	2.70E-8	1.21E-8	9.04E-9
7.5	2.91E-9	1.03E-8	2.12E-8	1.53E-8	4.73E-9	7.35E-9	6.06E-9	9.92E-9	3.32E-9	6.47E-9	9.54E-9	2.09E-8	1.32E-8	1.36E-8	6.09E-9	4.56E-9
10.0	1.92E-9	7.06E-9	1.44E-8	1.05E-8	3.19E-9	5.00E-9	4.08E-9	6.74E-9	2.24E-9	4.40E-9	6.48E-9	1.43E-8	8.93E-9	9.30E-9	4.15E-9	3.11E-9
15.0	1.07E-9	3.96E-9	8.06E-9	5.88E-9	1.78E-9	2.80E-9	2.28E-9	3.78E-9	1.25E-9	2.47E-9	3.64E-9	8.02E-9	5.02E-9	5.23E-9	2.34E-9	1.75E-9
20.0	7.14E-10	2.83E-9	5.72E-9	4.24E-9	1.25E-9	1.99E-9	1.59E-9	2.68E-9	8.73E-10	1.75E-9	2.57E-9	5.75E-9	3.53E-9	3.73E-9	1.66E-9	1.25E-9
25.0	5.22E-10	2.18E-9	4.39E-9	3.30E-9	9.51E-10	1.53E-9	1.20E-9	2.06E-9	6.62E-10	1.34E-9	1.97E-9	4.45E-9	2.69E-9	2.88E-9	1.27E-9	9.62E-10
30.0	4.04E-10	1.77E-9	3.55E-9	2.69E-9	7.63E-10	1.24E-9	9.55E-10	1.66E-9	5.28E-10	1.08E-9	1.58E-9	3.61E-9	2.16E-9	2.33E-9	1.03E-9	7.78E-10
35.0	3.26E-10	1.48E-9	2.96E-9	2.26E-9	6.34E-10	1.04E-9	7.89E-10	1.38E-9	4.37E-10	8.98E-10	1.32E-9	3.03E-9	1.80E-9	1.95E-8	8.58E-10	6.51E-10
40.0	2.71E-10	1.27E-9	2.54E-9	1.95E-9	5.41E-10	8.88E-10	6.69E-10	1.18E-9	3.72E-10	7.67E-10	1.13E-9	2.60E-9	1.53E-9	1.68E-9	7.34E-10	5.58E-10
45.0	2.30E-10	1.11E-9	2.21E-9	1.71E-9	4.70E-10	7.75E-10	5.79E-10	1.03E-9	3.22E-10	6.68E-10	9.82E-10	2.28E-9	1.33E-9	1.46E-9	6.40E-10	4.87E-10
50.0	1.99E-10	9.85E-10	1.96E-9	1.52E-9	4.15E-10	6.87E-10	5.09E-10	9.12E-10	2.83E-10	5.90E-10	8.68E-10	2.02E-9	1.17E-9	1.30E-9	5.66E-10	4.32E-10

TABLE 2.6-52

ESTIMATED SUMMER AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 200 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	4.29E-7	1.17E-6	1.65E-6	1.14E-6	3.39E-7	5.05E-7	3.75E-7	1.01E-6	1.55E-7	4.27E-7	7.68E-7	9.30E-7	7.44E-7	4.37E-7	3.35E-7	2.63E-7
0.2	5.45E-7	1.43E-6	2.20E-6	1.22E-6	3.62E-7	4.62E-7	6.10E-7	1.55E-6	4.41E-7	7.58E-7	9.00E-7	1.53E-6	1.23E-6	8.84E-7	5.49E-7	1.81E-7
0.3	4.28E-7	1.11E-6	1.75E-6	9.20E-7	2.76E-7	3.40E-7	4.90E-7	1.24E-6	3.82E-7	6.27E-7	7.01E-7	1.24E-6	9.88E-7	7.28E-7	4.54E-7	1.24E-7
0.5	2.47E-7	6.40E-7	1.01E-6	5.36E-7	1.52E-7	1.87E-7	2.84E-7	7.08E-7	2.25E-7	3.65E-7	4.01E-7	7.21E-7	5.59E-7	4.17E-7	2.66E-7	7.21E-8
0.8	1.34E-7	3.47E-7	5.48E-7	3.03E-7	7.78E-8	9.86E-8	1.52E-7	3.73E-7	1.18E-7	1.93E-7	2.14E-7	3.84E-7	2.88E-7	2.15E-7	1.41E-7	4.33E-8
1.0	9.77E-8	2.54E-7	4.00E-7	2.25E-7	5.53E-8	7.11E-8	1.10E-7	2.70E-7	8.44E-8	1.40E-7	1.55E-7	2.78E-7	2.05E-7	1.54E-7	1.02E-7	3.29E-8
1.5	5.46E-8	1.42E-7	2.24E-7	1.29E-7	2.98E-8	3.91E-8	6.13E-8	1.48E-7	4.60E-8	7.68E-8	8.60E-8	1.54E-7	1.11E-7	8.36E-8	5.65E-8	1.95E-8
2.5	2.61E-8	6.83E-8	1.07E-7	6.33E-8	1.37E-8	1.84E-8	2.91E-8	7.00E-8	2.16E-8	3.63E-8	4.08E-8	7.31E-8	5.16E-8	3.89E-8	2.68E-8	9.75E-9
3.5	1.61E-8	4.21E-8	6.59E-8	3.94E-8	8.32E-9	1.12E-8	1.79E-8	4.29E-8	1.32E-8	2.22E-8	2.51E-8	4.49E-8	3.14E-8	2.37E-8	1.64E-8	6.13E-9
4.5	1.12E-8	2.94E-8	4.60E-8	2.76E-8	5.75E-9	7.80E-9	1.25E-8	2.98E-8	9.17E-9	1.55E-8	1.75E-8	3.12E-8	2.17E-8	1.64E-8	1.15E-8	4.33E-9
7.5	5.45E-9	1.43E-8	2.24E-8	1.36E-8	2.73E-9	3.75E-9	6.03E-9	1.43E-8	4.41E-9	7.46E-9	8.45E-9	1.51E-8	1.03E-8	7.83E-9	5.54E-9	2.16E-9
10.0	3.65E-9	9.56E-9	1.50E-8	9.14E-9	1.80E-9	2.49E-9	4.02E-9	9.54E-9	2.93E-9	4.97E-9	5.64E-9	1.01E-8	6.84E-9	5.19E-9	3.70E-9	1.46E-9
15.0	2.05E-9	5.36E-9	8.40E-9	5.12E-9	1.01E-9	1.39E-9	2.26E-9	5.35E-9	1.65E-9	2.80E-9	3.16E-9	5.65E-9	3.84E-8	2.91E-9	2.08E-9	8.17E-10
20.0	1.40E-9	3.67E-9	5.73E-9	3.56E-9	6.73E-10	9.40E-10	1.53E-9	3.61E-9	1.11E-9	1.89E-9	2.15E-9	3.83E-9	2.55E-9	1.94E-9	1.41E-9	5.79E-10
25.0	1.04E-9	2.74E-9	4.27E-9	2.69E-9	4.91E-10	6.96E-10	1.14E-9	2.66E-9	8.10E-10	1.39E-9	1.60E-9	2.83E-9	1.86E-9	1.42E-9	1.04E-9	4.44E-10
30.0	8.20E-10	2.16E-9	3.37E-9	2.14E-9	3.80E-10	5.45E-10	8.91E-10	2.08E-9	6.29E-10	1.09E-9	1.25E-9	2.22E-9	1.44E-9	1.10E-9	8.14E-10	3.58E-10
35.0	6.71E-10	1.77E-9	2.75E-9	1.77E-9	3.06E-10	4.43E-10	7.27E-10	1.69E-9	5.07E-10	8.82E-10	1.02E-9	1.81E-9	1.16E-9	8.84E-10	6.61E-10	2.99E-10
40.0	5.64E-10	1.49E-9	2.32E-9	1.50E-9	2.54E-10	3.71E-10	6.09E-10	1.41E-9	4.21E-10	7.36E-10	8.57E-10	1.51E-9	9.60E-10	7.33E-10	5.53E-10	2.56E-10
45.0	4.84E-10	1.28E-9	1.99E-9	1.30E-9	2.15E-10	3.17E-10	5.21E-10	1.20E-9	3.58E-10	6.28E-10	7.34E-10	1.29E-9	8.14E-10	6.21E-10	4.72E-10	2.23E-10
50.0	4.22E-10	1.12E-9	1.73E-9	1.14E-9	1.86E-10	2.76E-10	4.54E-10	1.05E-9	3.09E-10	5.44E-10	6.39E-10	1.12E-9	7.01E-10	5.35E-10	4.10E-10	1.97E-10

TABLE 2.6-53

ESTIMATED FALL AVERAGE χ/Q (sec/m^3) VALUES USING WIND DIRECTION AND SPEED AT 200 FT. LEVEL

Downwind Distance Miles	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.1	5.50E-7	8.66E-7	1.11E-6	6.10E-7	3.28E-7	3.49E-7	3.98E-7	5.51E-7	2.18E-7	4.46E-7	4.57E-7	1.28E-6	8.98E-7	7.32E-7	3.00E-7	3.59E-7
0.2	4.94E-7	9.59E-7	1.62E-6	9.04E-7	3.46E-7	4.32E-7	6.29E-7	8.69E-7	3.81E-7	7.65E-7	8.41E-7	2.07E-6	1.10E-6	1.18E-6	5.00E-7	4.39E-7
0.3	3.52E-7	7.36E-7	1.31E-6	7.47E-7	2.59E-7	3.34E-7	4.98E-7	7.00E-7	3.04E-7	6.11E-7	7.02E-7	1.68E-6	8.76E-7	9.61E-7	4.10E-7	3.36E-7
0.5	2.11E-7	4.37E-7	8.24E-7	4.88E-7	1.66E-7	1.89E-7	3.07E-7	4.24E-7	1.77E-7	3.57E-7	4.49E-7	1.02E-6	5.31E-7	5.84E-7	2.64E-7	1.88E-7
0.8	1.30E-7	2.51E-7	4.95E-7	3.04E-7	1.07E-7	1.01E-7	1.83E-7	2.43E-7	9.62E-8	1.94E-7	2.71E-7	5.87E-7	3.05E-7	3.33E-7	1.62E-7	9.90E-8
1.0	9.96E-8	1.88E-7	3.77E-7	2.35E-7	8.41E-8	7.29E-8	1.39E-7	1.82E-7	7.05E-8	1.43E-7	2.06E-7	4.39E-7	2.29E-7	2.49E-7	1.25E-7	7.15E-8
1.5	5.96E-8	1.09E-7	2.23E-7	1.41E-7	5.15E-8	4.03E-8	8.20E-8	1.06E-7	3.96E-8	8.03E-8	1.22E-7	2.54E-7	1.32E-7	1.43E-7	7.47E-8	3.93E-8
2.5	3.01E-8	5.34E-8	1.12E-7	7.16E-8	2.64E-8	1.91E-8	4.10E-8	5.20E-8	1.90E-8	3.86E-8	6.13E-8	1.25E-7	6.50E-8	7.05E-8	3.78E-8	1.85E-8
3.5	1.90E-8	3.34E-8	7.04E-8	4.54E-8	1.68E-8	1.17E-8	2.57E-8	3.24E-8	1.17E-8	2.38E-8	3.86E-8	7.80E-8	4.06E-8	4.40E-8	2.39E-8	1.13E-8
4.5	1.34E-8	2.35E-8	4.98E-8	3.22E-8	1.20E-8	8.14E-9	1.82E-8	2.28E-8	8.19E-9	1.67E-8	2.73E-8	5.48E-8	2.86E-8	3.09E-8	1.69E-8	7.85E-9
7.5	6.70E-9	1.16E-8	2.48E-8	1.62E-8	6.03E-9	3.92E-9	9.03E-9	1.13E-8	3.98E-9	8.10E-9	1.36E-8	2.70E-8	1.41E-8	1.52E-8	8.47E-9	3.77E-9
10.0	4.55E-9	7.81E-9	1.69E-8	1.10E-8	4.12E-9	2.61E-9	6.12E-9	7.59E-9	2.66E-9	5.42E-9	9.26E-9	1.83E-8	9.55E-9	1.03E-8	5.76E-9	2.50E-9
15.0	2.54E-9	4.38E-9	9.48E-9	6.20E-9	2.31E-9	1.46E-9	3.43E-9	4.26E-9	1.49E-9	3.04E-9	5.21E-9	1.03E-8	5.37E-9	5.78E-9	3.24E-9	1.40E-9
20.0	1.81E-9	3.05E-9	6.68E-9	4.40E-9	1.65E-9	9.90E-10	2.41E-9	2.97E-9	1.02E-9	2.08E-9	3.67E-9	7.14E-9	3.74E-9	4.02E-9	2.29E-9	9.44E-10
25.0	1.39E-9	2.32E-9	5.10E-9	3.38E-9	1.28E-9	7.34E-10	1.84E-9	2.24E-9	7.61E-10	1.55E-9	2.80E-9	5.40E-9	2.83E-9	3.03E-9	1.76E-9	6.97E-10
30.0	1.12E-9	1.85E-9	4.10E-9	2.72E-9	1.04E-9	5.75E-10	1.48E-9	1.79E-9	6.00E-10	1.22E-9	2.25E-9	4.31E-9	2.26E-9	2.42E-9	1.42E-9	5.45E-10
35.0	9.38E-10	1.53E-9	3.41E-9	2.27E-9	8.71E-10	4.68E-10	1.23E-9	1.48E-9	4.92E-10	1.00E-9	1.87E-9	3.56E-9	1.87E-9	2.00E-9	1.18E-9	4.43E-10
40.0	8.03E-10	1.30E-9	2.91E-9	1.94E-9	7.48E-10	3.92E-10	1.05E-9	1.26E-9	4.14E-10	8.44E-10	1.60E-9	3.02E-9	1.59E-9	1.69E-9	1.01E-9	3.70E-10
45.0	7.01E-10	1.13E-9	2.53E-9	1.69E-9	6.54E-10	3.36E-10	9.09E-10	1.09E-9	3.55E-10	7.26E-10	1.39E-9	2.61E-9	1.37E-9	1.46E-9	8.79E-10	3.16E-10
50.0	6.21E-10	9.90E-10	2.23E-9	1.50E-9	5.80E-10	2.92E-10	8.02E-10	9.55E-10	3.10E-10	6.34E-10	1.22E-9	2.30E-9	1.21E-9	1.28E-9	7.76E-10	2.74E-10

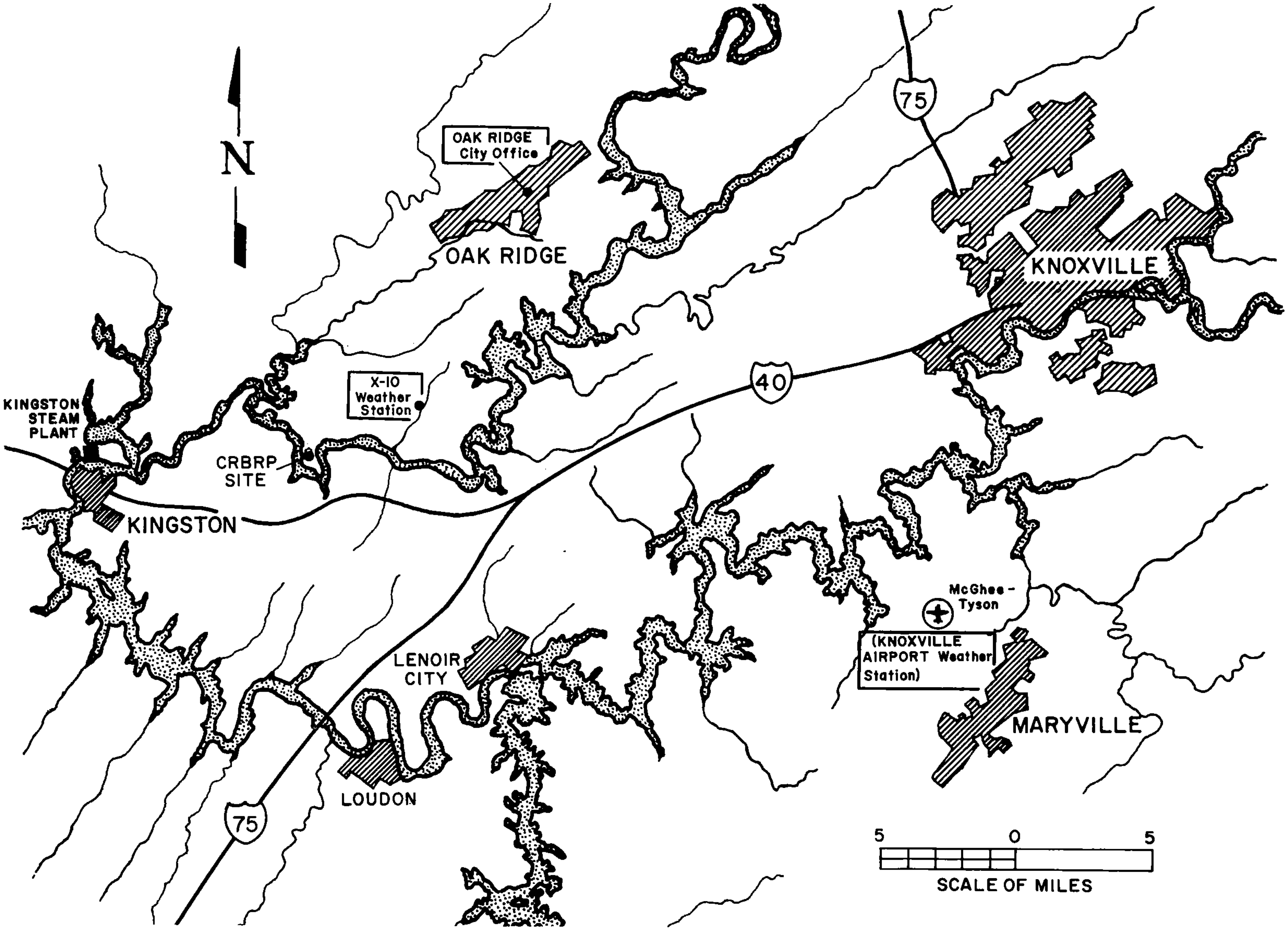

Figure 2.6-1 LOCATIONS OF WEATHER STATIONS NEAR SITE

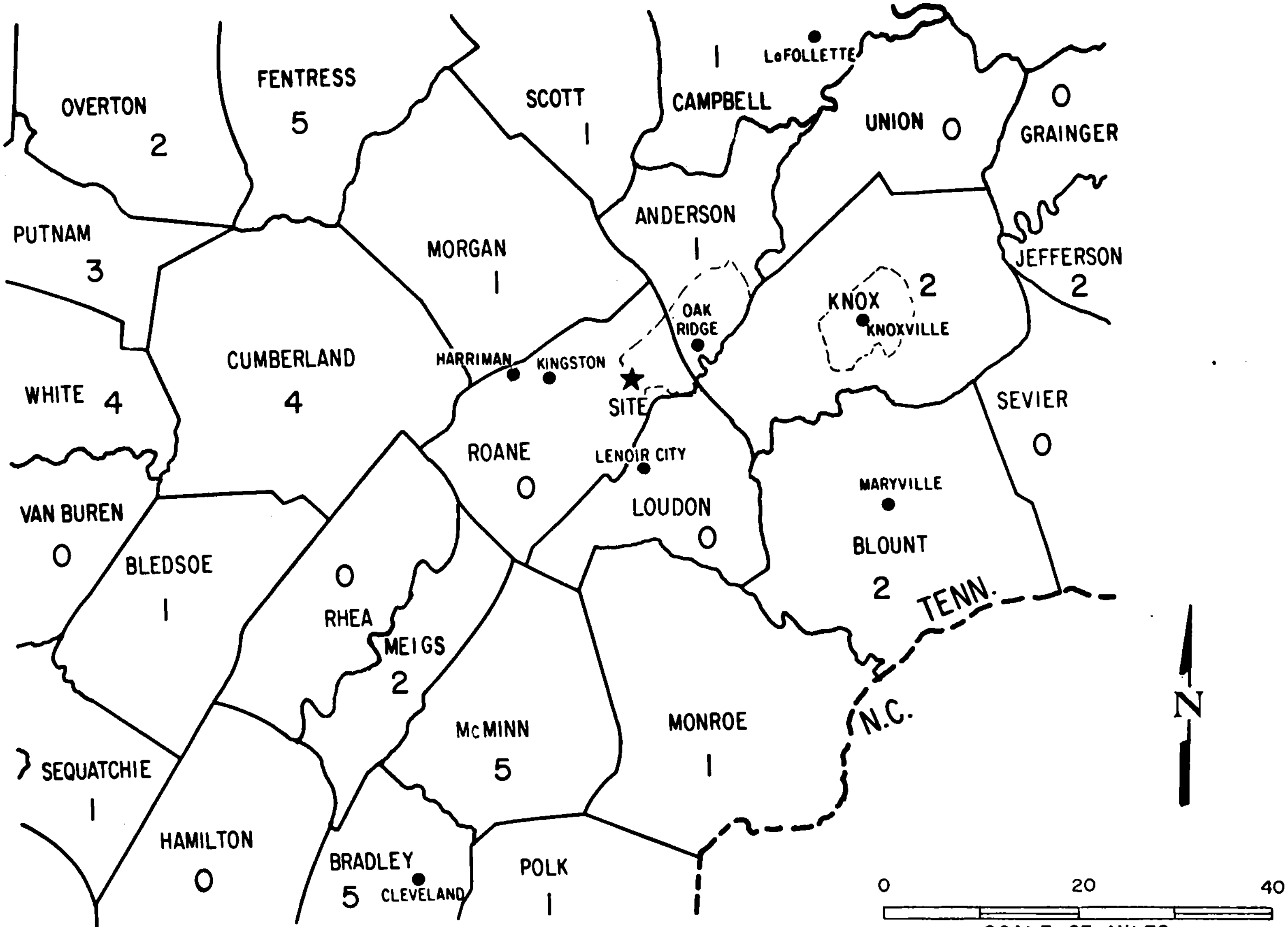

Figure 2.6-2 RAW COUNT DATA ON TORNADO OCCURENCE FOR COUNTIES NEAR SITE, 1916 - 1972

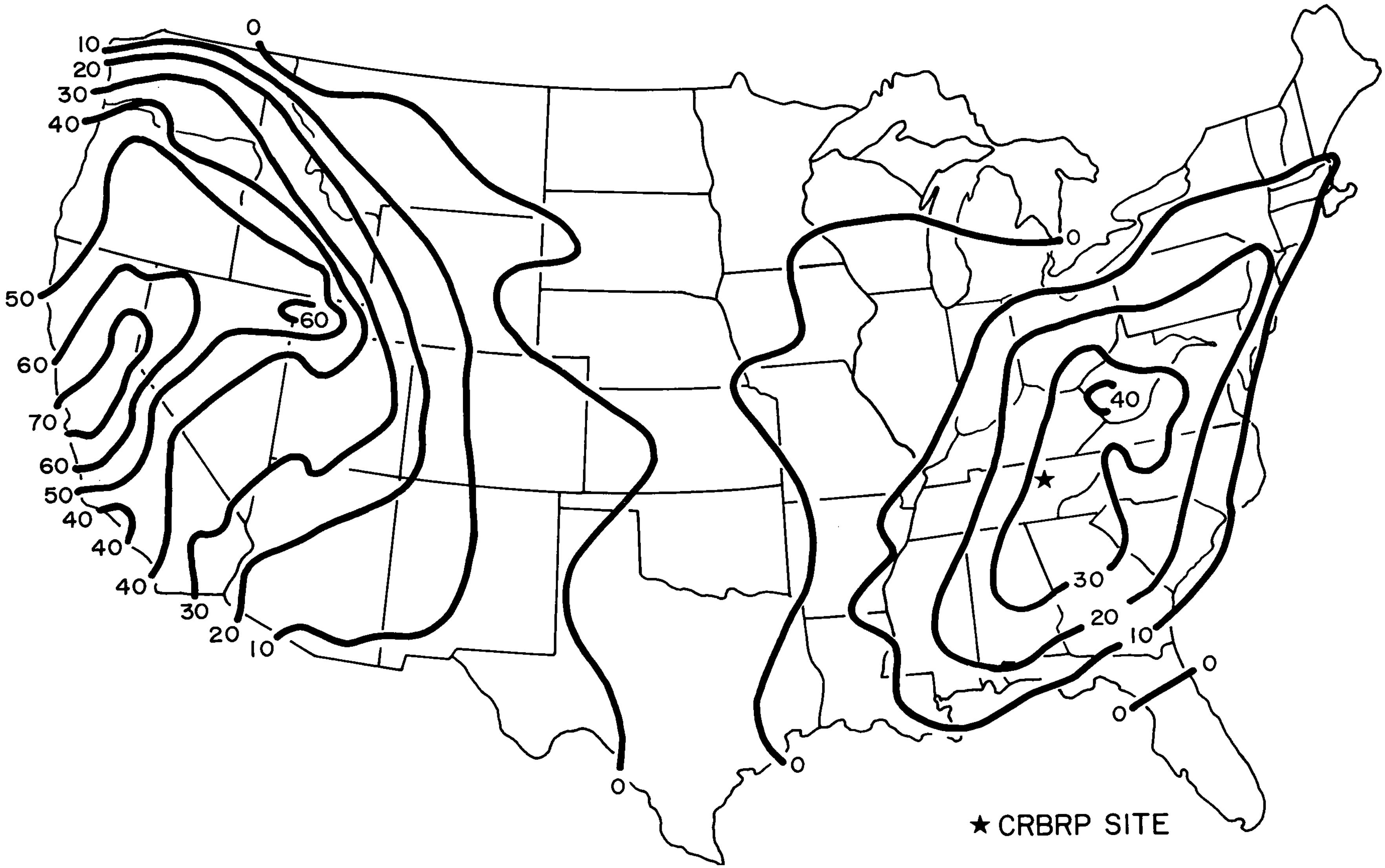

Figure 2.6-3 TOTAL NUMBER OF FORECAST DAYS OF HIGH METEOROLOGICAL POTENTIAL FOR HIGH AIR POLLUTION IN A 5-YEAR PERIOD(23)

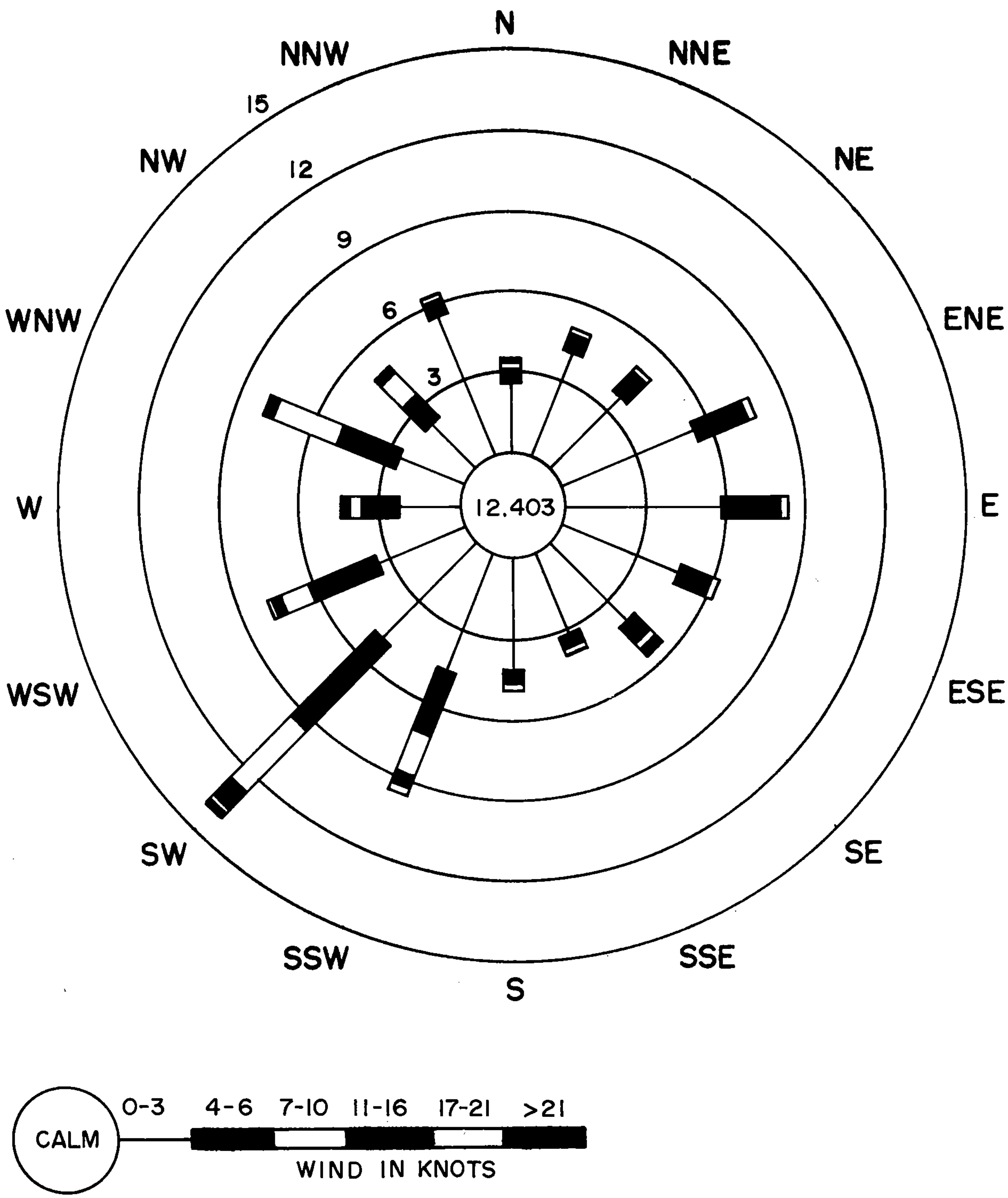

Figure 2.6-4 ANNUAL WIND ROSE FOR THE 75 FOOT LEVEL FROM CRBRP ON-SITE METEOROLOGICAL DATA FOR JULY 1973 THROUGH JUNE 1974

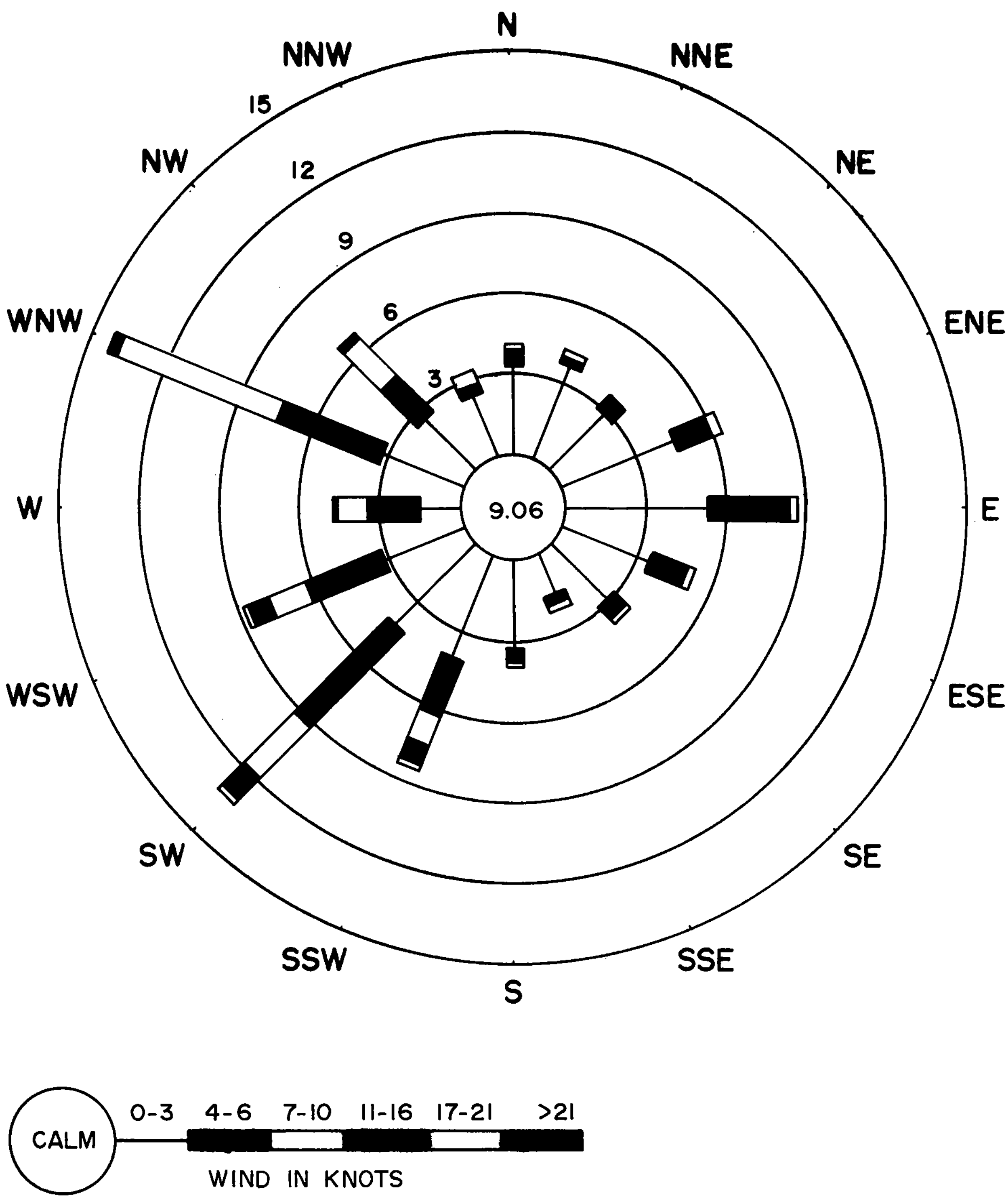

Figure 2.6-5 WINTER WIND ROSE FOR THE 75 FOOT LEVEL FROM CRBRP ON-SITE METEOROLOGICAL DATA

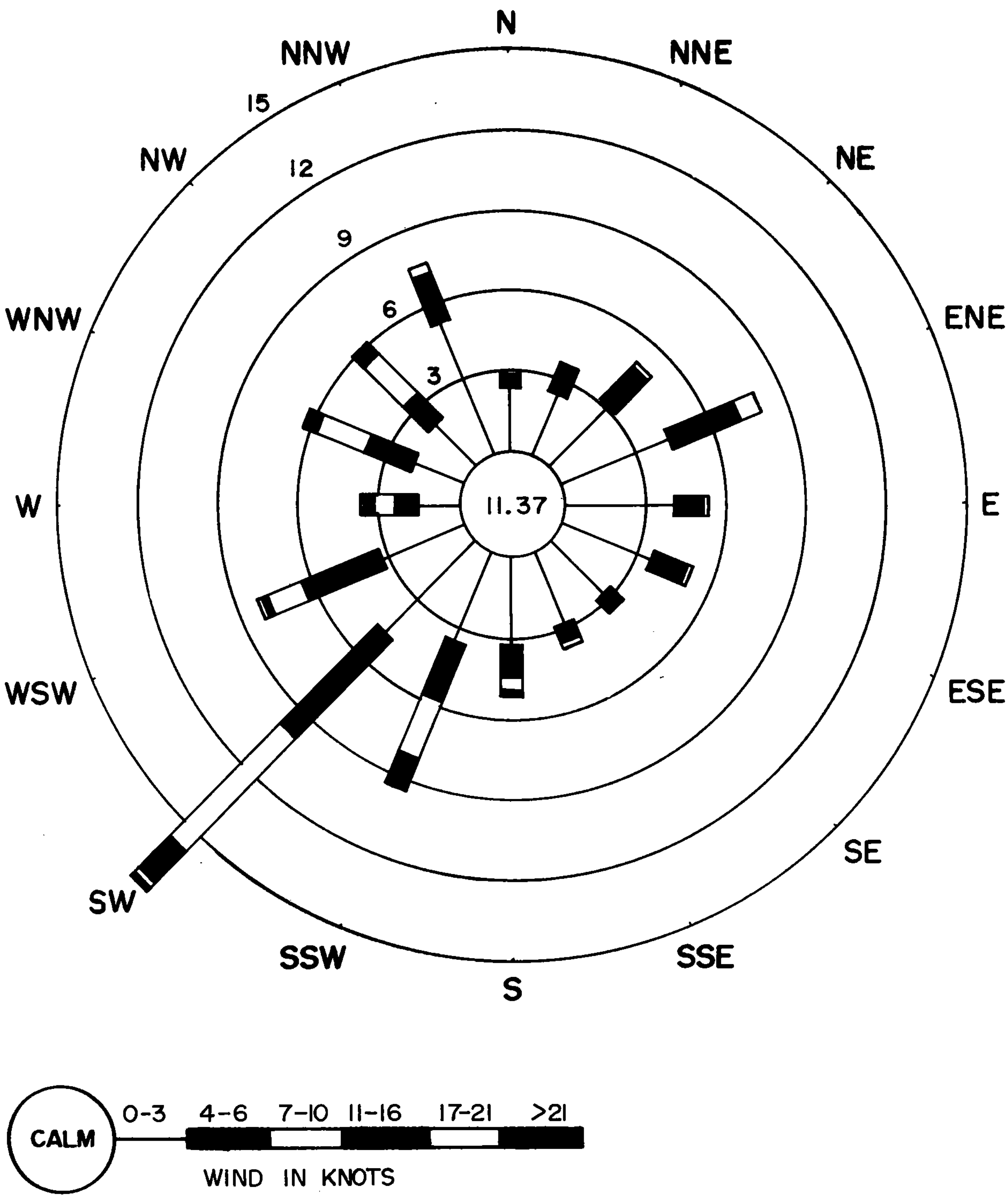

Figure 2.6-6 SPRING WIND ROSE FOR THE 75 FOOT LEVEL FROM CRBRP ON-SITE METEOROLOGICAL DATA

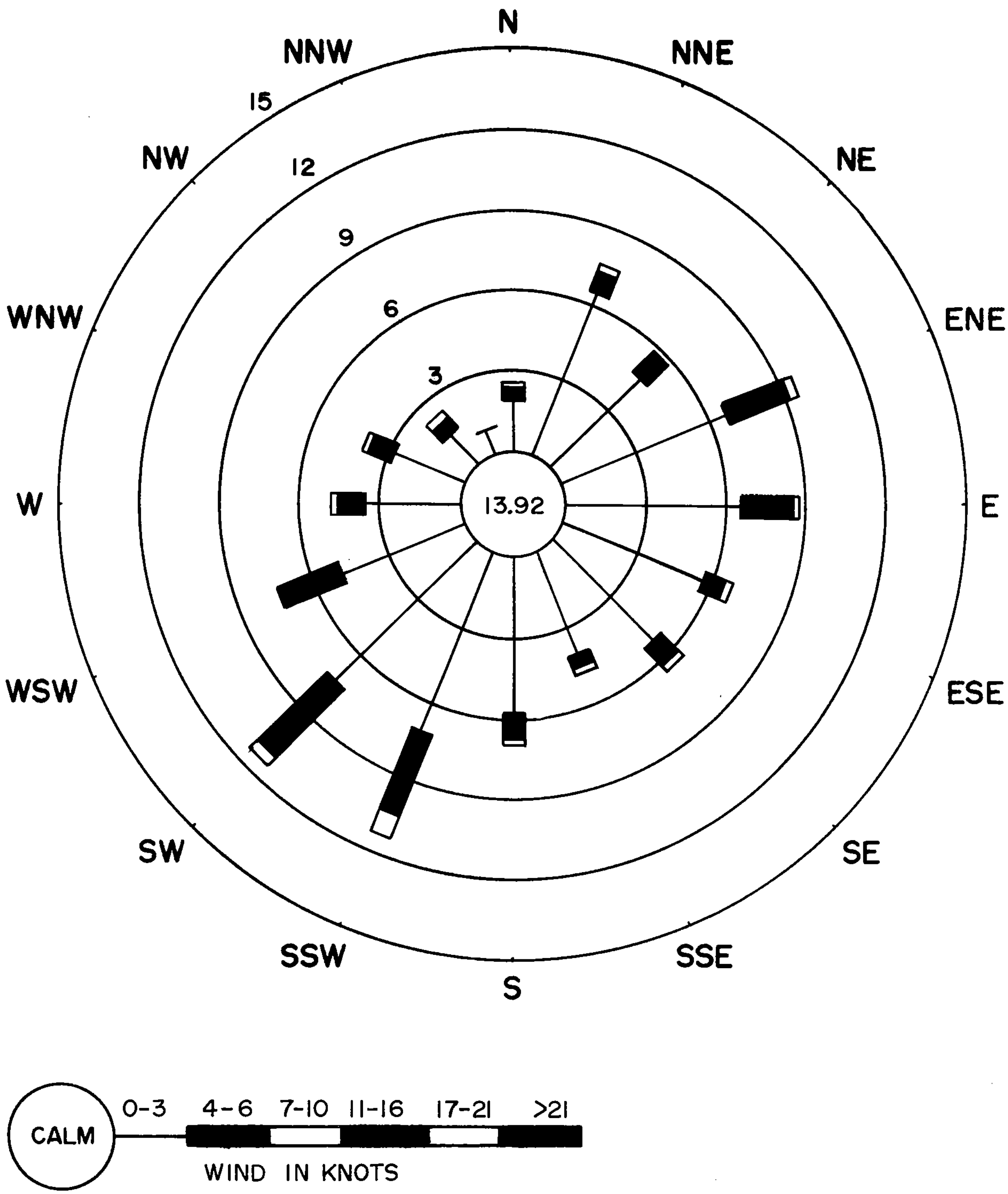

Figure 2.6-7 SUMMER WIND ROSE FOR THE 75 FOOT LEVEL FROM CRBRP ON-SITE METEOROLOGICAL DATA

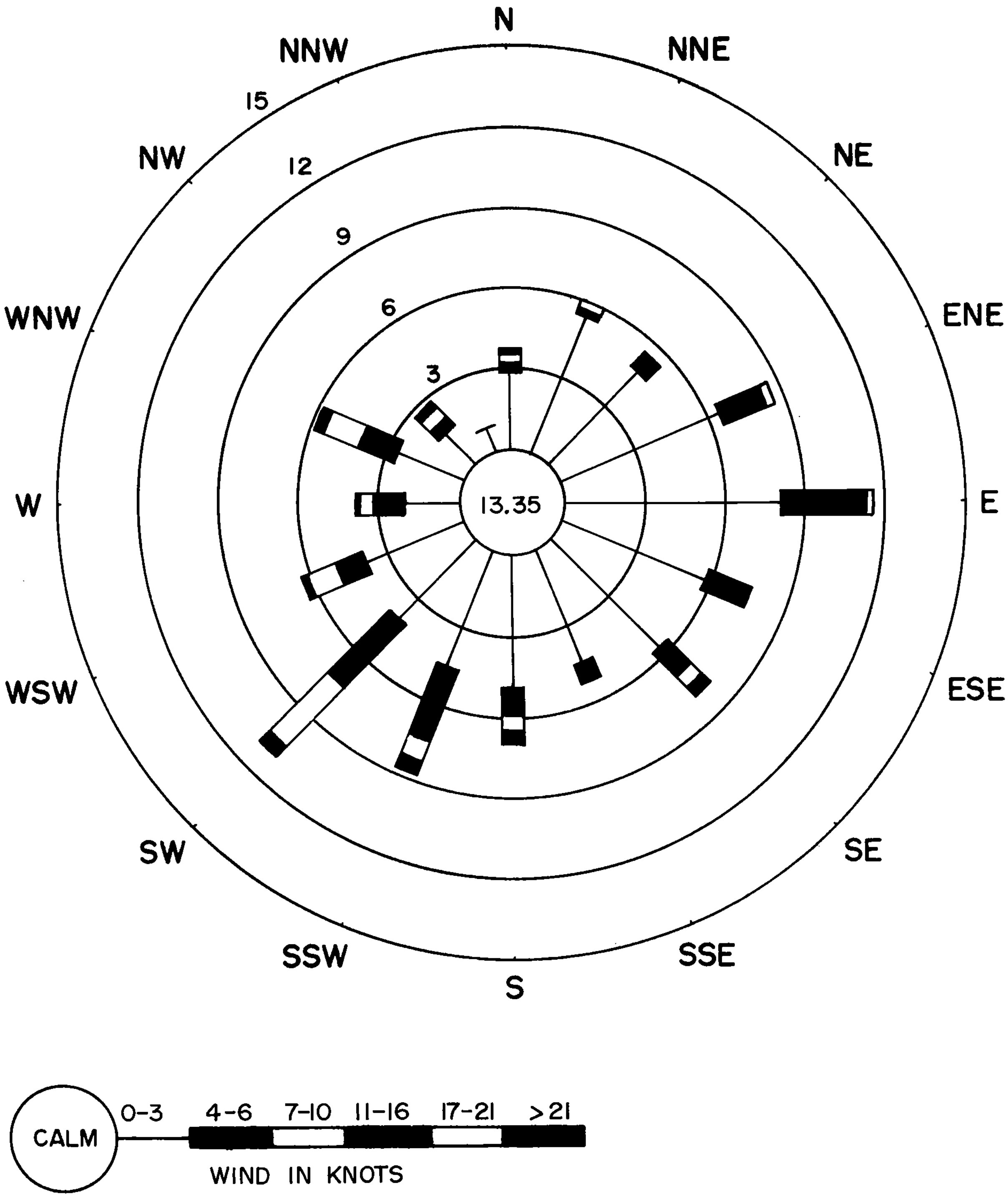

Figure 2.6-8 FALL WIND ROSE FOR THE 75 FOOT LEVEL FROM CRBRP ON-SITE METEOROLOGICAL DATA

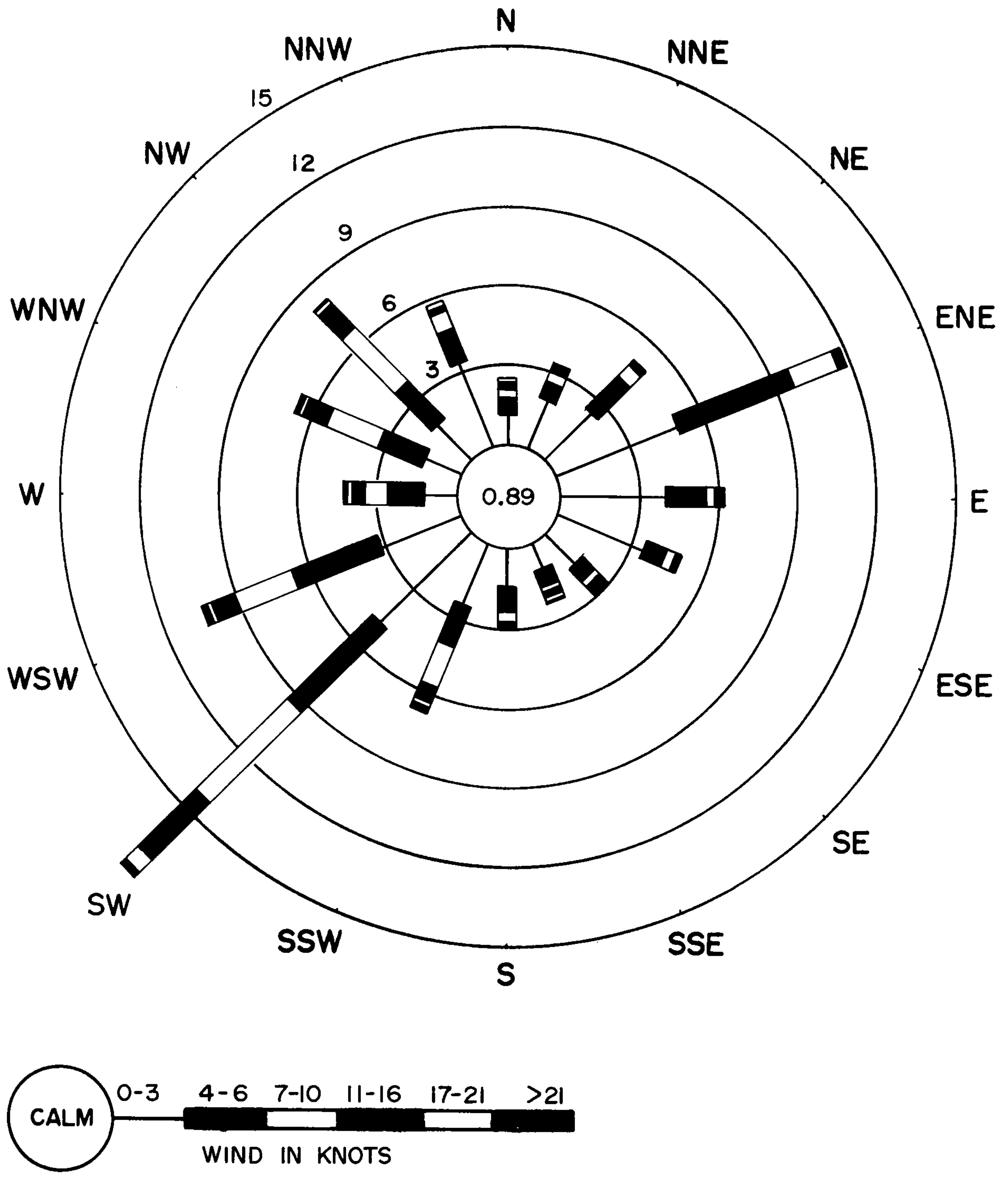

Figure 2.6-9 ANNUAL WIND ROSE FOR THE 200 FOOT LEVEL FROM THE CRBRP ON-SITE METEOROLOGICAL DATA FOR JULY 1973 THROUGH JUNE 1974

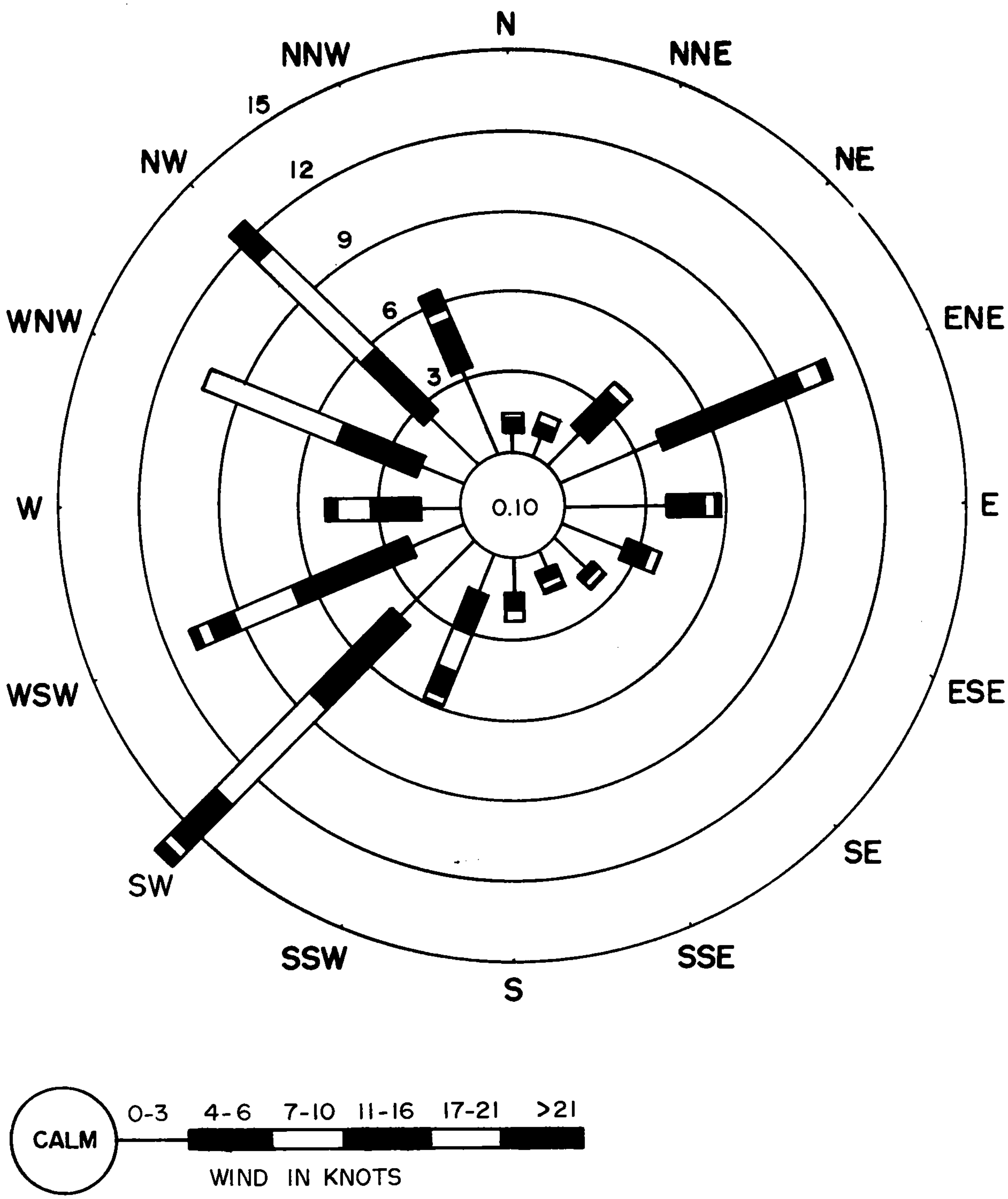

Figure 2.6-10 WINTER WIND ROSE FOR THE 200 FOOT LEVEL FROM THE CRBRP ON-SITE METEOROLOGICAL DATA

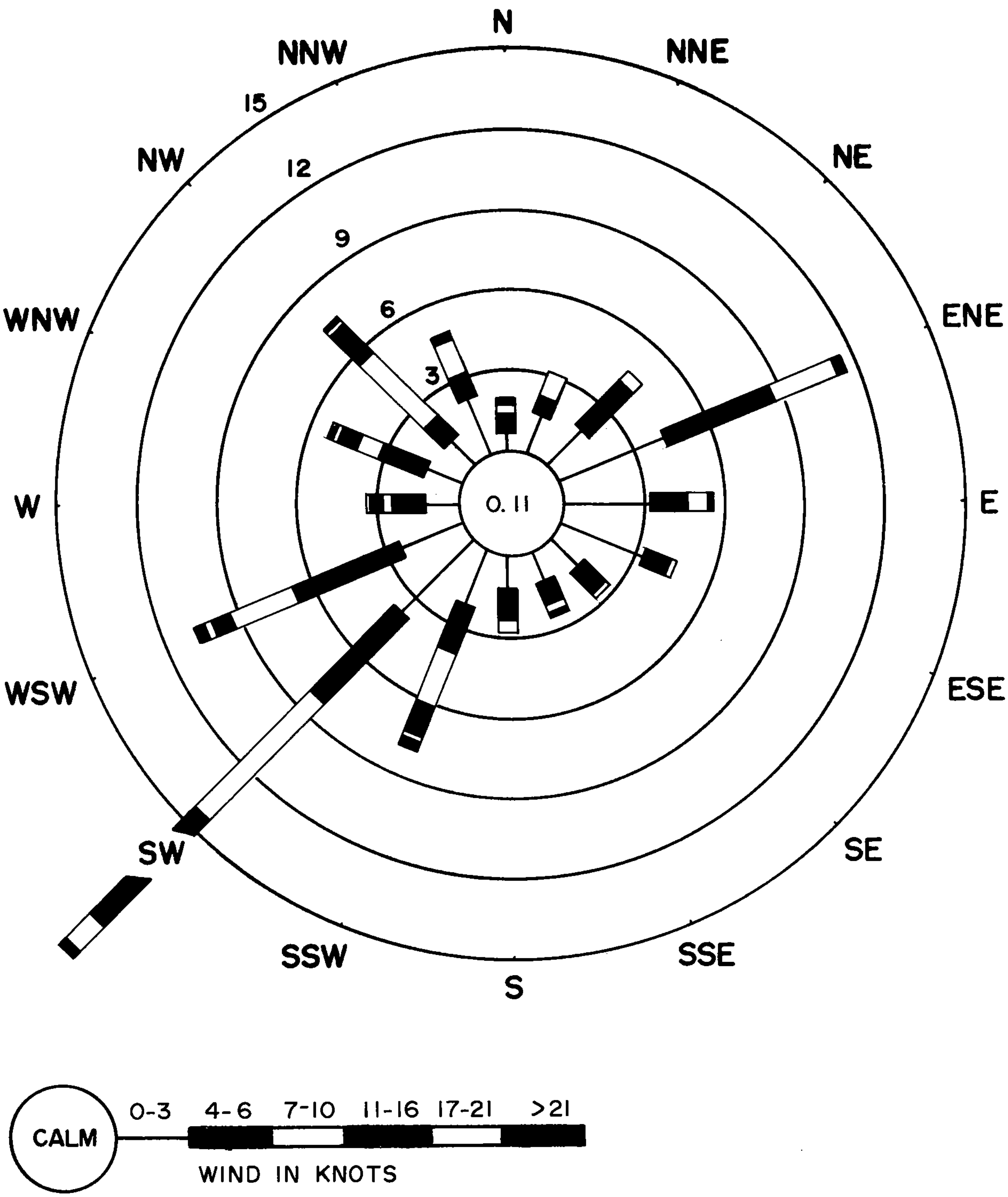

Figure 2.6-11 SPRING WIND ROSE FOR THE 200 FOOT LEVEL FROM THE CRBRP ON-SITE METEOROLOGICAL DATA

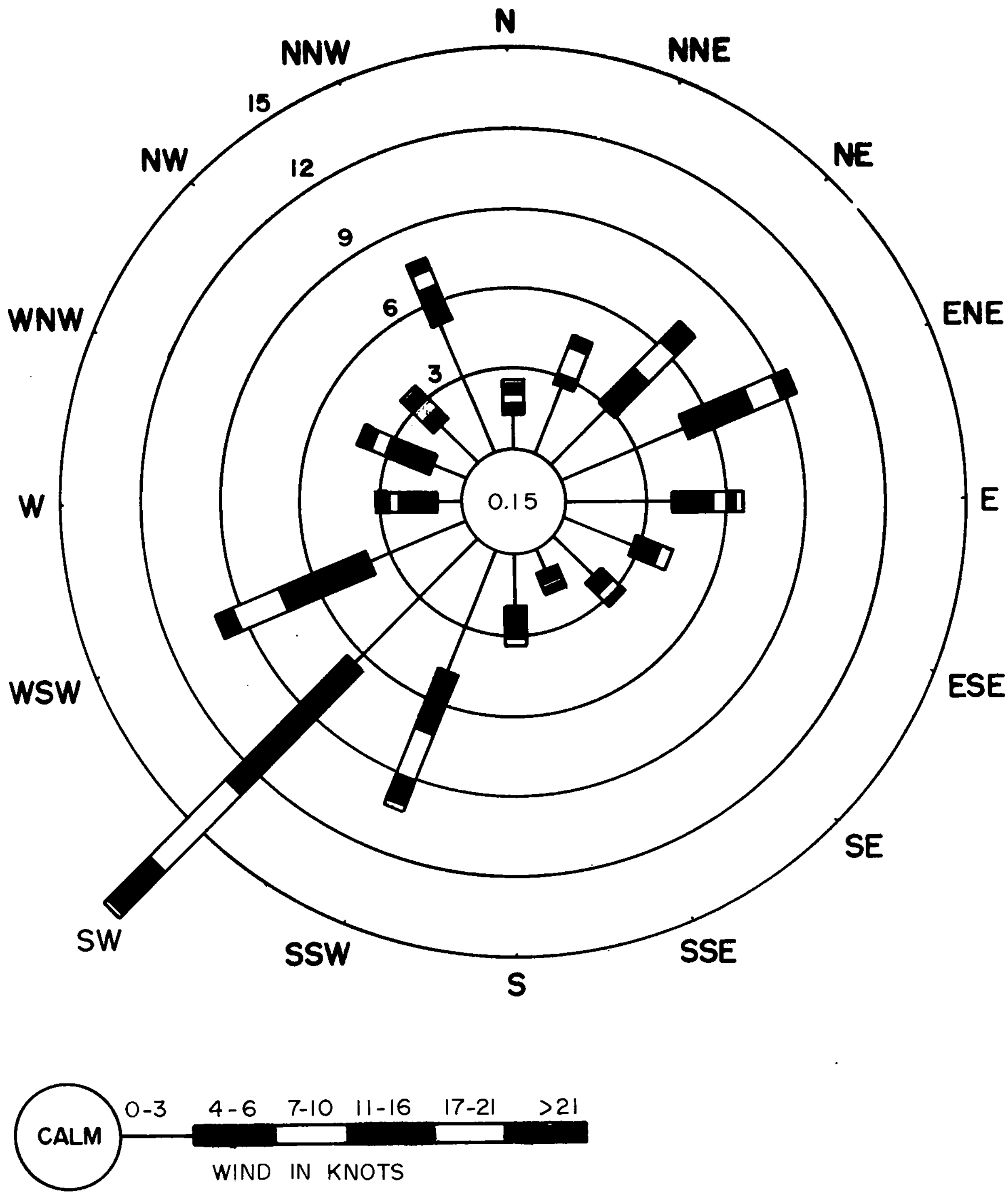

Figure 2.6-12 SUMMER WIND ROSE FOR THE 200 FOOT LEVEL FROM THE CRBRP ON-SITE METEOROLOGICAL DATA

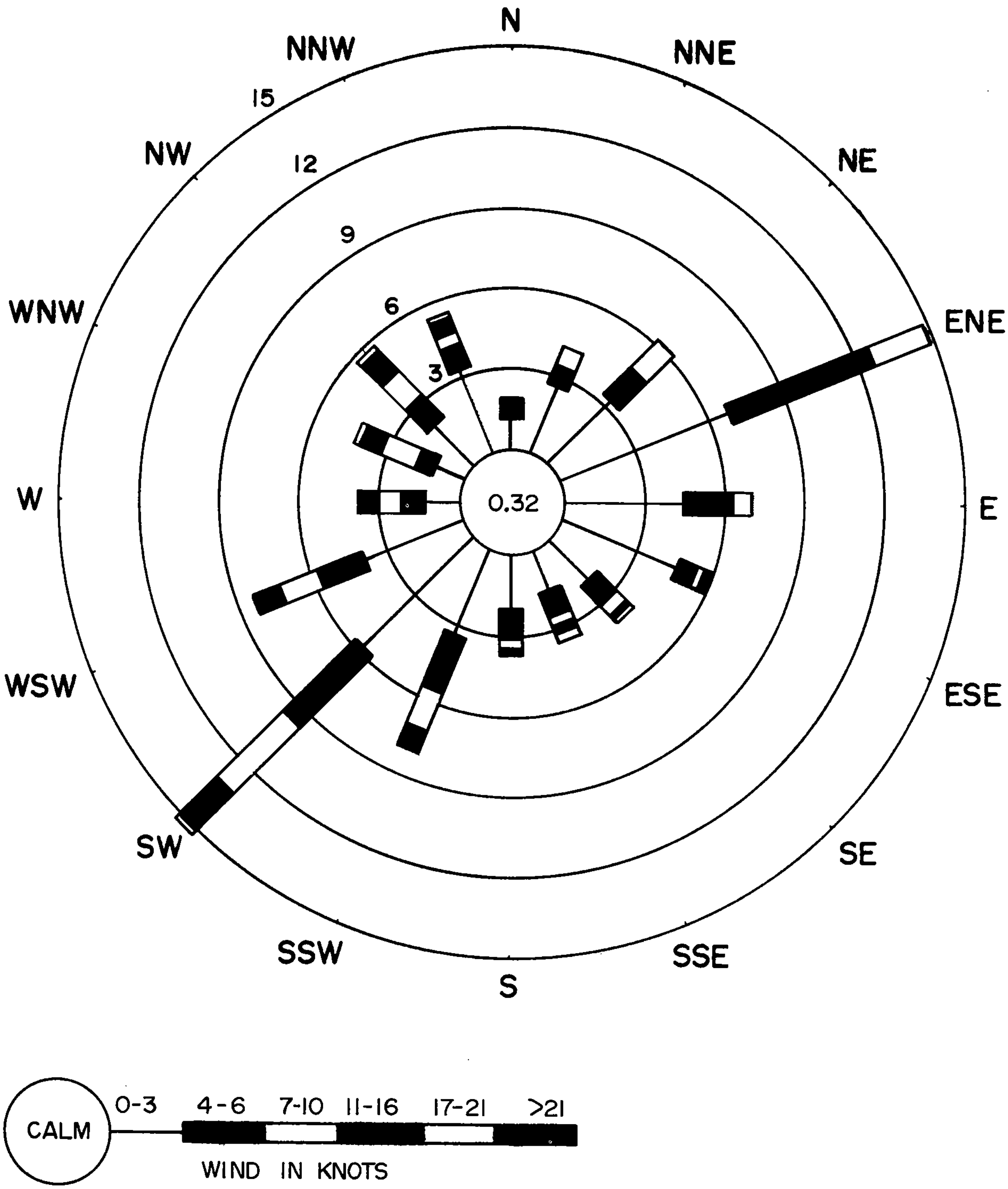

Figure 2.6-13 FALL WIND ROSE FOR THE 200 FOOT LEVEL FROM THE CRBRP ON-SITE METEOROLOGICAL DATA

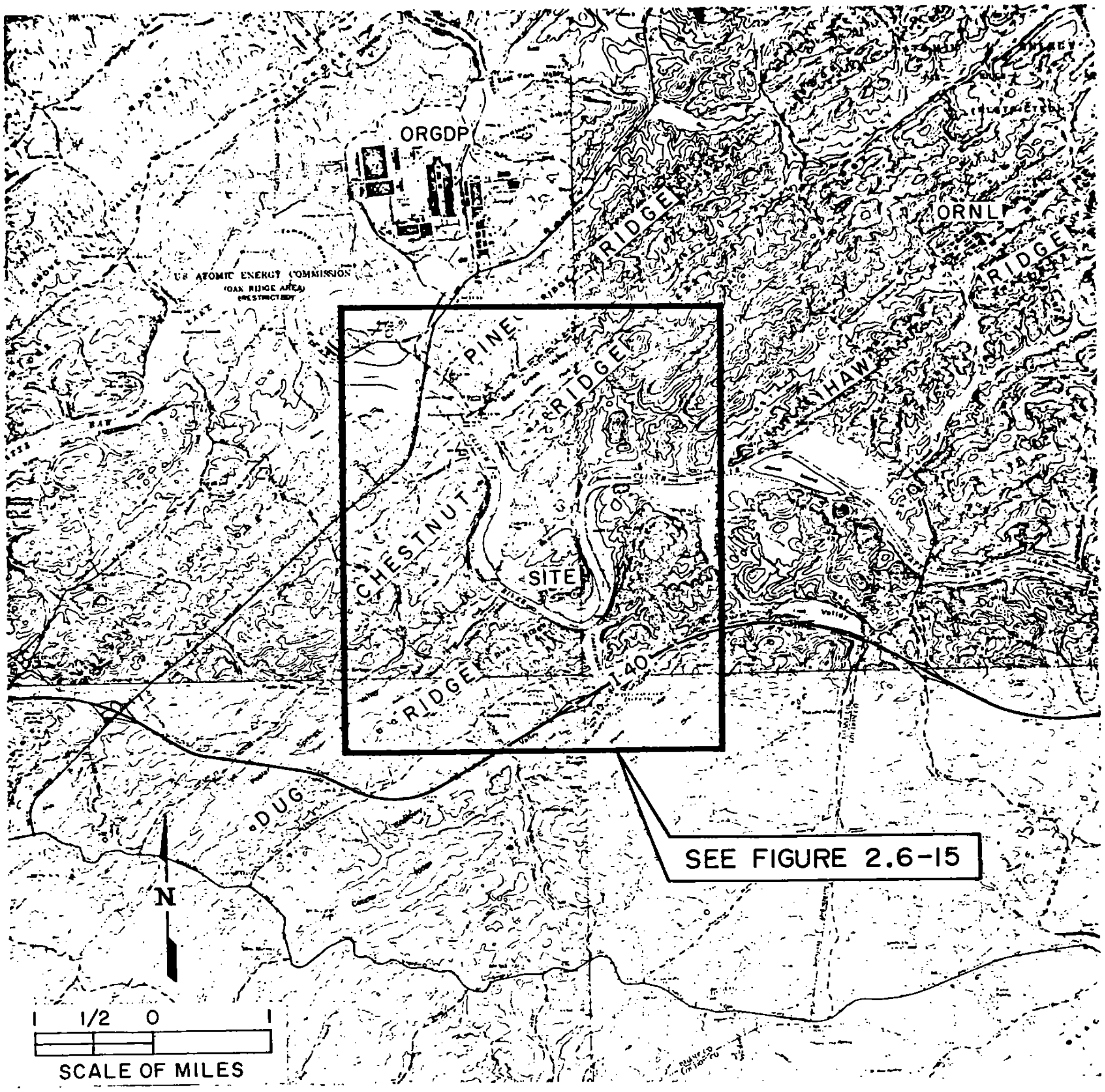

Figure 2.6-14 TOPOGRAPHY SURROUNDING CLINCH RIVER SITE

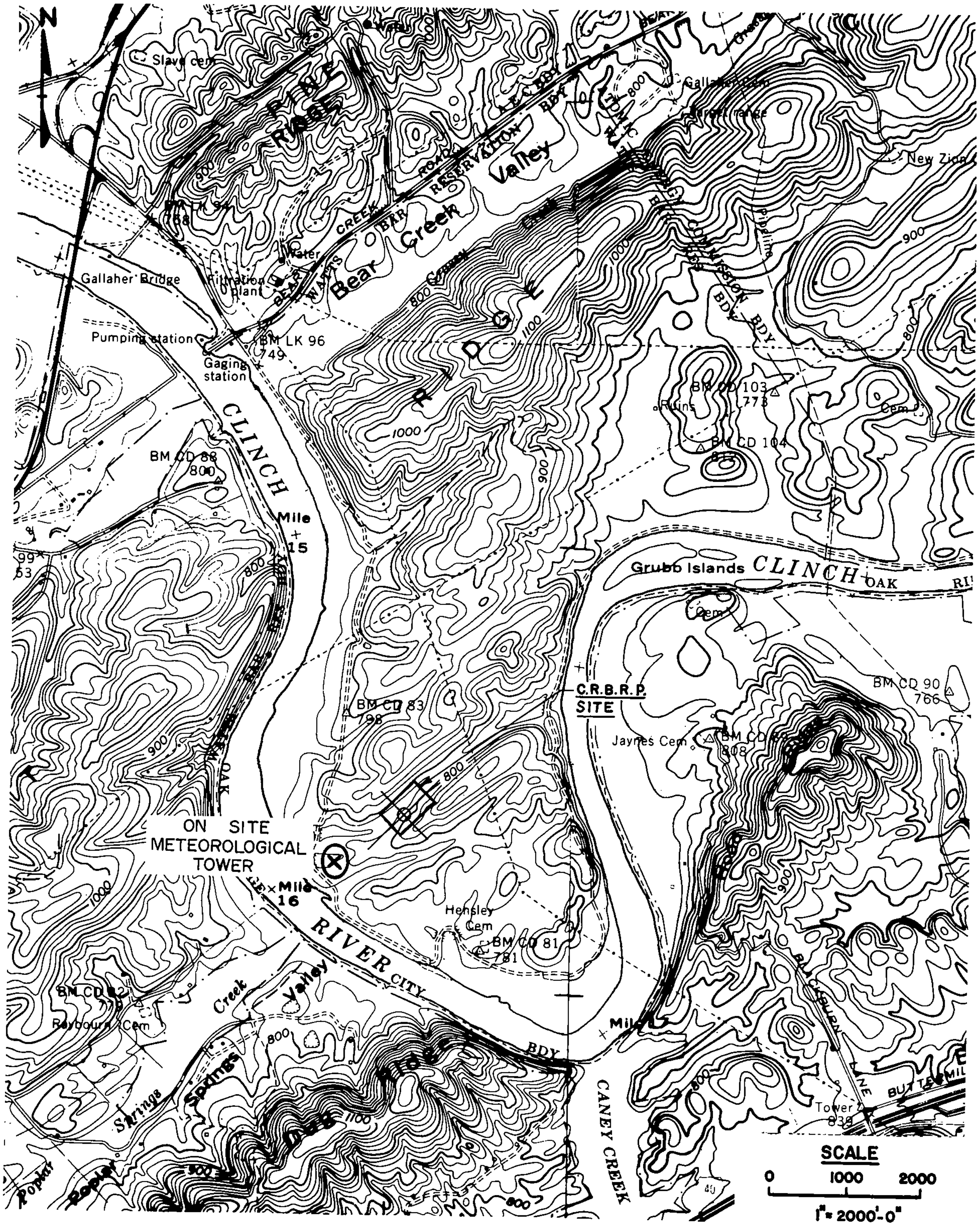

Figure 2.6-15 SITE TOPOGRAPHIC MAP

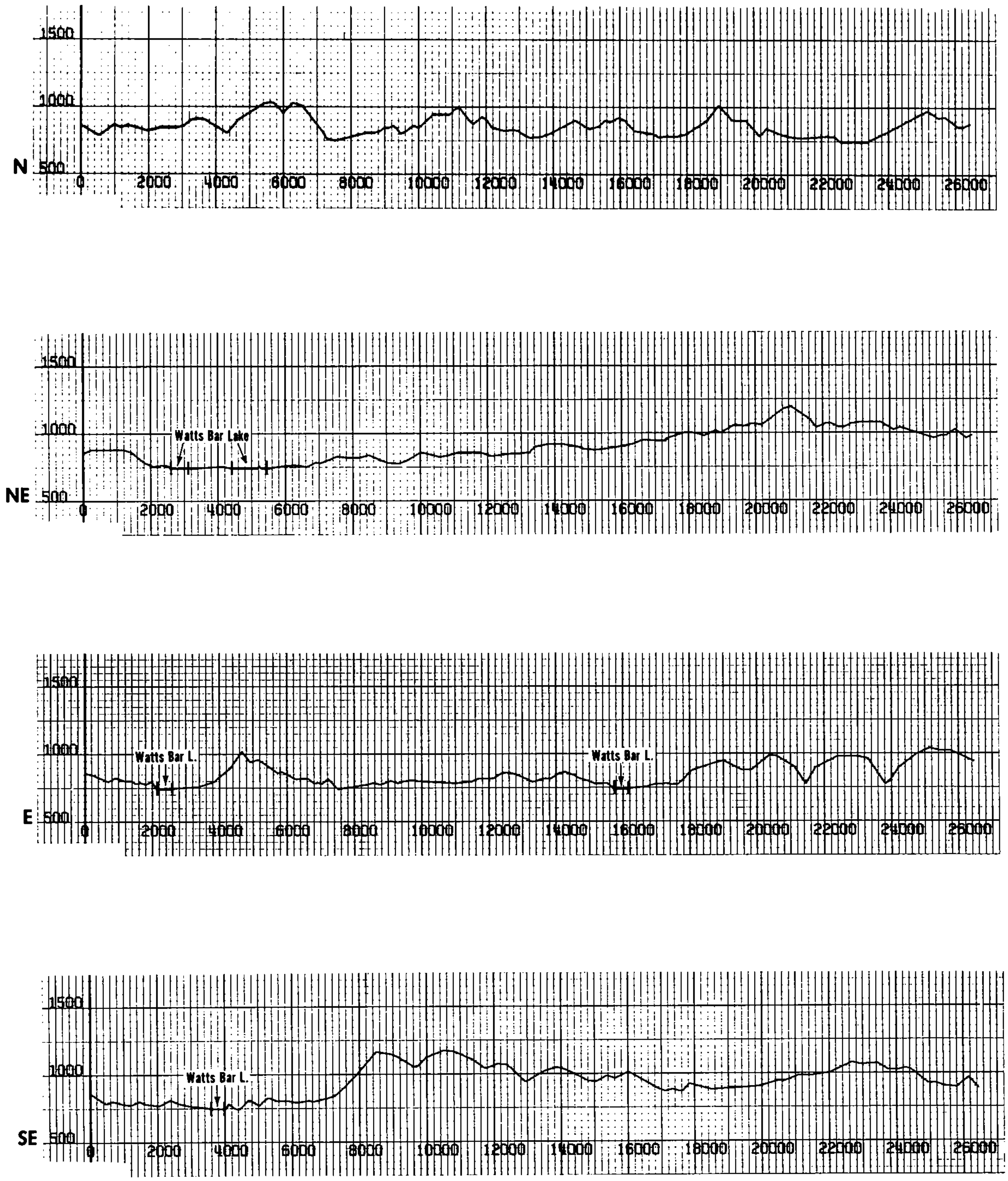

Figure 2.6-16 TOPOGRAPHIC PROFILE CROSS SECTIONS FROM SITE (sheet 1 of 2)

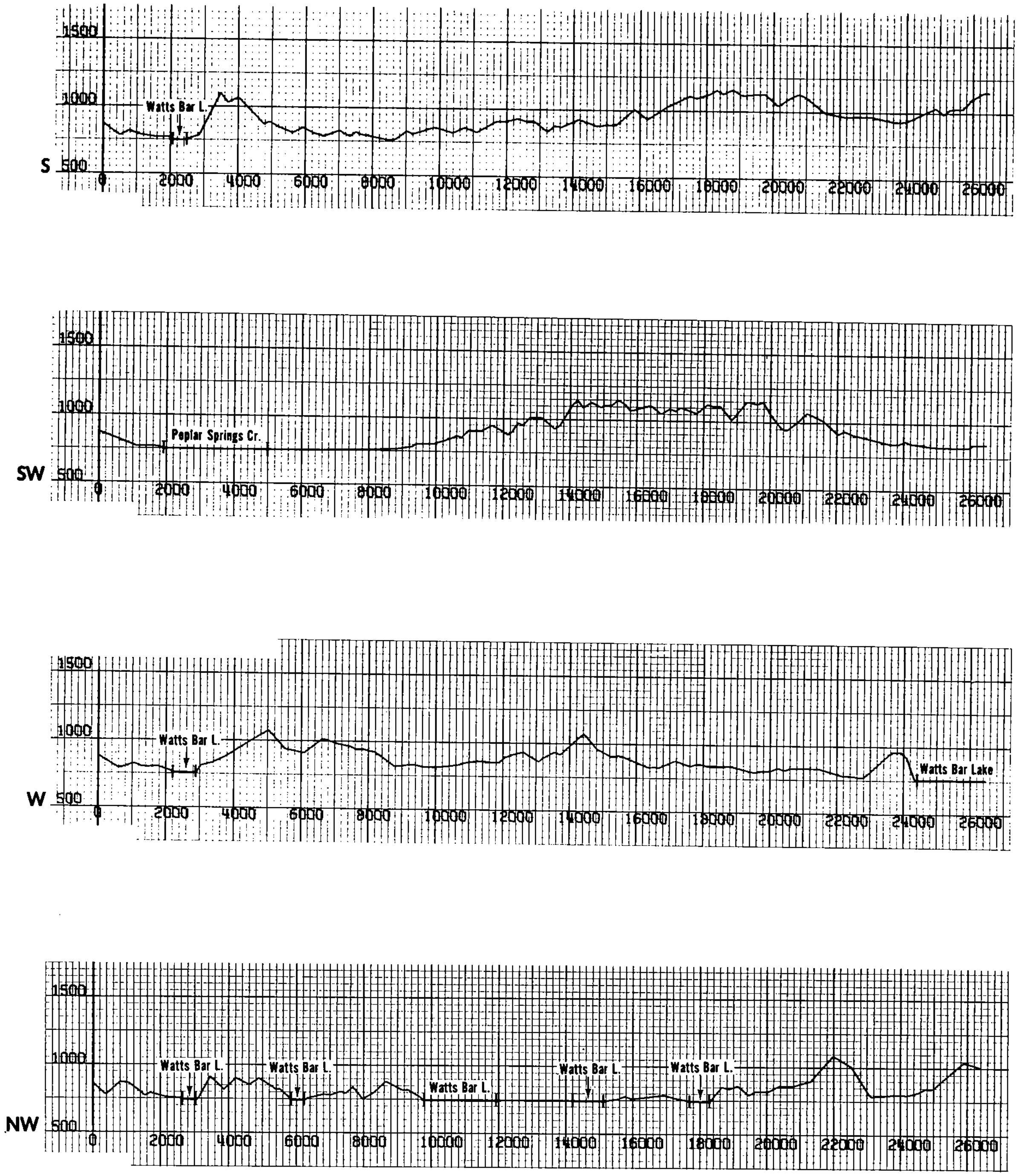

Figure 2.6-16 TOPOGRAPHIC PROFILE CROSS SECTIONS FROM SITE (sheet 2 of 2)

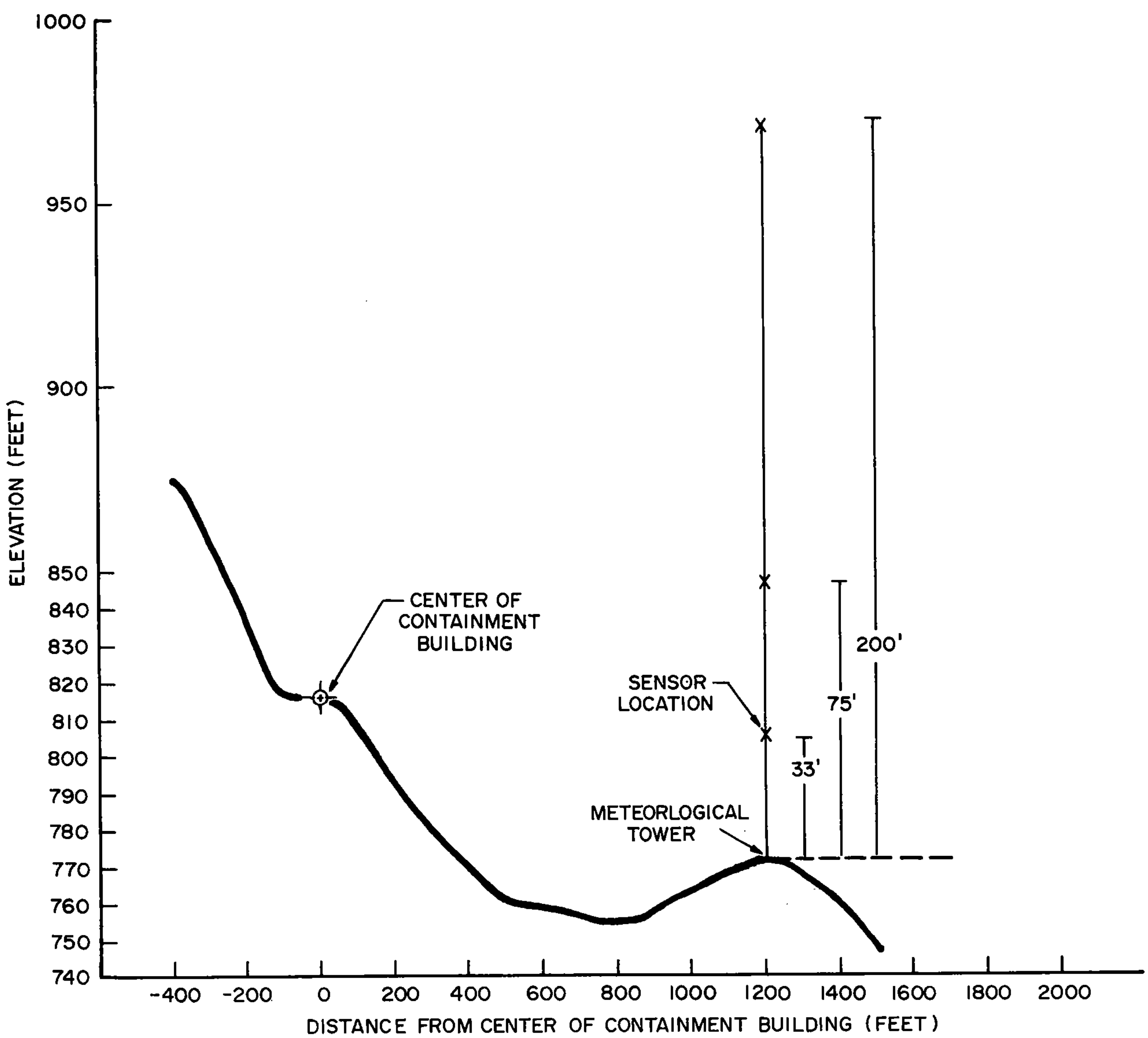

Figure 2.6-17 TOPOGRAPHICAL CROSS SECTION INCLUDING METEOROLOGICAL TOWER AND CENTER OF CONTAINMENT BUILDING

PURPOSELY
BLANK

2.7 ECOLOGY

2.7.1 TERRESTRIAL ECOLOGY

Ecology of the Site and a detailed description of the flora and fauna of the Site and the surrounding area, are presented in this section. The Site, which is similar to the surrounding area in geology, soil composition and overstory vegetation, consists of mostly forested land on shallow infertile soil overlying shale and dolomitic rock formations. Numerous, comprehensive ecological studies have been conducted by the Oak Ridge National Laboratory (ORNL) which is located nearby. Where appropriate, ORNL studies have been cited to supplement the on-site data.

2.7.1.1 LAND USE HISTORY

Prior to 1942, the Oak Ridge Area was primarily inhabited by agricultural families. In spite of generally steep slopes and shallow, relatively infertile soil, cultivation and other agricultural and forestry practices were employed in the area. These included pasture for beef cattle, tobacco for commercial use and hay and vegetables for personal and limited commercial use.(1) These activities resulted in minor to extensive disturbance of the forest ecosystem depending on the activity.

The tract of land on which the plant will be located was formerly part of the Oak Ridge Reservation; however, it was transferred to TVA in March 1968 and is no longer part of the Oak Ridge Reservation. Since that time, the reservation area not used for industrial purposes has been managed mostly for forest production and used for ecological and biological research. However, the Site was marked for industrial development and the area could not be expected to remain undeveloped.

In 1964, the most recent forest management program for the area was started to combat an outbreak of the southern pine beetle. At that time, all infected trees were harvested. Over the past few years, the management program has harvested about five percent of all trees in the area, which is approximately equal to the new growth.[2] The loblolly pine (Pinus taeda) plantations are being selectively cut, while all the shortleaf pine (Pinus echinata) plantations will be clear cut.[3]

2.7.1.2 SOILS

Soils found on the Site are not well suited to agricultural crops,[4] but are better suited to the currently employed forestry practices. The soils of the Site which are typical of the surrounding area,[4,5] lie on fairly rough terrain; over 60 percent of the land has a slope of greater than 20 percent and over 40 percent of the land has a slope greater than 30 percent. The soil is generally shallow and contains much chert and small rocks. Poor suitability of the soil for agricultural purposes is illustrated by its high permeability and low fertility (pH 4.2 to 4.6 and low in exchangeable bases nitrate and phosphate).[5]

Soils of the CRBRP Site are quite variable. Soil types from residuum, colluvium and alluvium are present throughout the area. The major soils found in the area are Fullerton, Clarksville, Upshur and Colbert. Other soils that occur are Pope, Sequatchie, Wolftever, Armuchee, Talbott, Roane and Waynesboro. A soils map of the CRBRP Site is presented in Figure 2.7-1 and a list of soils in the area is presented in Table 2.7-1.[4,6] General characteristics of the soils are given in the following subsections.

2.7.1.2.1 FULLERTON SERIES

This series consists of deep, well-drained soils developed on broad rounded hills and ridges in residuum weathered from cherty dolomitic limestone.[6] Slopes range from gentle to very steep. Where uneroded, Fullerton soils have a surface soil of yellowish-brown silt loam or cherty silt loam and a subsoil of yellowish-red to red clay or cherty clay. Productivity is influenced by the amount of chert, slope and degree of erosion on this soil.

2.7.1.2.2 CLARKSVILLE SERIES

Clarksville soils are light colored, very deep soils that developed from residuum weathered from very cherty dolomitic limestone.[6] The soil mass consists of about 15 to 50 percent chert fragments--this makes the soil porous and consistently droughty. Irregular, weakly to moderately dissected hills and ridges and sometimes karst topography (many sinkholes present) generally describe the landscape where this soil is found. Clarksville soils are low in fertility, contain little organic matter and are highly acid. Low moisture-supplying capacity and low natural fertility make this soil's response to management slight.

2.7.1.2.3 COLBERT SERIES

Colbert soils are fine textured, very plastic and moderately shallow (20 to 25 inches deep).[6] They have developed on uplands from materials weathered from clayey limestone. The limestone is generally massive, but is flaggy or even shaley in some places. These soils are well drained externally, but they contain large amounts of clay; therefore, water and air move through them very slowly. Surface area of this soil is grayish-brown clay which is very firm when dry and very plastic when wet. Because this soil is slowly permeable, it is subject to sheet erosion and therefore requires careful management.

2.7.1.2.4 UPSHUR SERIES

Upshur soils are characterized by their purple color, heavy texture, shallowness over bedrock and neutral or slightly alkaline reaction. They are derived from purplish-red highly argillaceous or shaley limestones.[6]

The relief is rolling and the soils are well drained, both externally and internally. In some places they contain limestone fragments and they often occur in narrow elongated strips in valleys in association chiefly with the Colbert and Talbott soils. The surface soil is a purplish-brown, friable silty clay loam and the subsoil is a purplish-red or purplish-brown, tight sticky plastic clay or silty clay. This soil is highly susceptible to accelerated erosion because of the prevailing rolling slope. Crops are unsuited for this soil, but grass grows very well.

2.7.1.2.5 MINOR SOILS

The remaining soils are of minor importance (cover less area) compared to the soils already listed; however, they do need to be mentioned.[6] Pope and Roane soils are found in narrow strips along small streams. These soils are occasionally flooded and are receiving sediment while most soils not adjacent to streams are being eroded. Both soils have slow external drainage and good internal drainage.

Waynesboro and Wolftever soils occupy older terraces and are developed from deposits of stream alluvium.[6] These soils are well developed but quite different. Waynesboro soils, developed chiefly on the higher terraces from sandy material, are well drained (internally and externally) and have a moderate water-holding capacity. They are moderate to low in natural fertility and slight to moderate in erodibility. Wolftever soils have developed from limestone and shale material, lie on low terraces and are subject to flooding. They have slow internal drainage, are low in productivity and have a slight degree of erosion.

Sequatchie soils are young in geologic age, although older than the Pope soils.[6] They are well drained and friable throughout. Degree of erodibility is slight and natural productivity is moderate to high. These soils occur on lower-lying terraces than the Waynesboro and show some profile development. Talbott soils are similar to the Colbert in characteristics, but are redder and shallower to bedrock than Colbert.

Armuchee soils are derived from shale.[6] They are well drained, have an acid reaction and contain shale fragments. The soil material ranges from 10 to 20 inches deep over shale.

2.7.1.2.6 SOIL INTERPRETATIONS

Figure 2.7-2 is a map showing the ranking of soils according to their susceptibility to erosion.[6] Soils in the slight category do not erode easily, while the soil in the slight to moderate category erodes more easily. Moderate indicates that some attention must be given to prevent unnecessary soil erosion. Moderate to severe indicates soils that have a wide range in their degree of erosion depending upon steepness of slope, length of slope and vegetation cover. Severe indicates that intensive treatment and/or special equipment and methods of operation should be planned to minimize soil erosion. The potential erosion hazard is based upon slope, soil depth, erodibility and soil-loss tolerance. Generally, the soils on the Site are slight and slight to moderate in their degree of erosion.[7]

Figure 2.7-3 illustrates impact potential of heavy equipment due to soil fragility.[6] The potential effect of heavy equipment is rated according to restrictions which may be needed to minimize the impact on the soils of the Site. Slight indicates that heavy equipment will seldom be limited during the year. Slight to moderate indicates some heavy equipment restrictions may be required. A rating of moderate shows there may be a need for modified or seasonal limitation due to slope, stones, obstructions, soil wetness, flooding or overflow. Moderate to severe indicates a possible greater need for modification of equipment use; a severe rating may require greatly restricted use of heavy equipment to reduce its impact potential due to one or more of the above factors.[4]

Seedling mortality (revegetation capability) rates for the soils on the CRBRP Site are shown in Figure 2.7-4.[6] Normal rainfall, adequate site preparation, good planting stock, proper planting methods and appropriate protection and cultivation are assumed. Slight indicates that 75 percent or more of those seedlings planted will survive. A slight to moderate rating indicates that approximately 70 to 80 percent will survive; 50 to 75 percent will survive if the rating is moderate. Approximately 45 to 55 percent will survive in the moderate to severe rating and less than 50 percent of the seedlings will survive if the rating is severe. This rating provides a planning tool for regeneration.

Figure 2.7-5 represents the natural productivity in a single-factor map.[6] A high rating means that the soil is capable of producing high crop yields even without supplemental amendments. Moderate to high ratings require a slight degree of management to raise productivity to a high level. Moderate ratings indicate special management in the form of additions of lime and fertilizer plus other types of soil conservation measures such as erosion control or structural improvement. Low to moderate ratings need very special management measures. Low natural productivity indicates that the topsoil has been removed by erosion or there are so many rocks and slopes are so steep that there is little natural fertility. The natural fertility/productivity is very important in revegetation and, to the extent practicable, it should be preserved during site preparation and construction.

2.7.1.3 VEGETATION AND FLORA

Vegetation on the forested CRBRP Site has been surveyed and permanent plots have been established in twelve community types as shown in Figure 2.7-6, Site Study Areas and Overstory Vegetation.

The results of the ground cover survey will be discussed in this section. For convenience, the plant communities and lists of species observed in each community are discussed first. Following this, successional trends, unusual or rare community types and plant species of special importance will be discussed. This information summarizes the vegetative data as collected to date. Sampling and data analysis methods are discussed in Section 6.1.

An inventory for the five-county area (Anderson, Knox, Roane, Morgan and Loudon counties) shows the occurrence of over 1,500 species of vascular plants.[8] The data indicate a rather wide distribution of most vascular plants throughout the entire area. Eight hundred and fifty species of these plants have been found on the Oak Ridge Reservation.

2.7.1.3.1 PLANT COMMUNITIES

The Site consists mostly of moderately to heavily wooded areas. Estimated vegetation cover of the Site is as follows:

Community Type	Acres	Percent of Site
Hardwood	498	37
Pine Plantation	411	30
Naturally Occurring Pine	120	9
Cedar and Pine	107	8
Hardwood and Cedar	75	5
Hardwood and Pine	52	4
Hardwood-Cedar-Pine	26	2
Non-forest	75	5
	1,364	100

An overstory vegetation map is found in Figure 2.7-6 with a list of species indicated on the legend. Although the land was originally forested, extensive clearing took place as a result of population settlement and cultivation; the entire Site appears to have been logged and/or pastured. Since cultivation of the land ceased in 1942, adequate time has elapsed for natural succession from field to forest in these areas.

Between 1948 and 1954, 411 acres of the Site were planted with various pine species.[9] This land has been maintained as a plantation, with little or no hardwood growing there. Elsewhere on the Site where the forest land has remained undisturbed, succession has occurred from Virginia pine (Pinus virginiana) and Eastern redcedar (Juniperus virginiana) covering to hardwood-pine-cedar forests. Even when hardwood becomes predominant, some pine remains.

During the survey period, sixteen study areas representing five major community types -- hardwood, natural pine, pine plantation, cedar and hardwood cedar communities -- were selected as representative samples of communities present on site and are shown in Figure 2.7-6. Community types are indicated by letter; multiple examples of the same community are indicated as E, E', etc. These study areas include six hardwood stands (A, D, J, L, L'), three natural pine stands (C, G, H), two pine plantations (B, I), four cedar glade vegetation areas (E, E', E'', E''') and two mixed hardwood and cedar communities (F, H). Study areas were also selected on the basis of their proximity to the plant site, expected high impact areas and the relatively undisturbed vegetation, termed natural areas.

HARDWOOD COMMUNITIES

Approximately 50 percent of the Site area is covered by mixed hardwood forests. These forests are far from uniform. Different associations of the oak-hickory forest type have developed in response to variations of slope, moisture, temperature and geologic conditions.[10] Generally, the dry, mixed hardwood associations are found on the higher slopes and ridge tops. With decreasing elevations and increasing moisture levels a more luxuriant mesic forest occurs.

Black oak (Quercus velutina), chestnut oak (Quercus prinus), scarlet oak (Quercus coccinea) and southern red oak (Quercus falcata) are the predominant species found in the thin soil of the dry rocky outcrops on the ridge areas (sampling areas K, L, and L'; Tables 2.7-2, 2.7-3 and 2.7-4, Woody Overstory Vegetation). Within these areas decaying stumps of American chestnut (Castanea dentata) are found. On these dry ridge top sites it is presumed that chestnut oak has replaced the American chestnut after that species died from chestnut blight. Common associates are white oak (Quercus alba), red oak (Quercus rubra), sugar maple (Acer saccharum), red maple (Acer rubrum), mockernut hickory (Carya tomentosa), pignut hickory (Carya glabra) and tulip poplar (Liriodendron tulipifera). These trees are generally even aged, reaching heights of 60 to 80 feet. An upper canopy closure of about 70 percent allows a moderate vegetative ground cover of about 70 percent. Much of the ground cover is overstory seedlings of red maple, sassafras and hickory.

Small trees and shrubs inhabit the woody understory as shown in Tables 2.7-5 through 2.7-22. Shrubs are more abundant in these dry forests compared to the more mesic forest association where the tree canopy intercepts more light. Included are hop hornbeam (Ostrya virginiana), flowering dogwood (Cornus florida) and Carolina buckthorn (Rhamnus carolinianus).

The woody and herbaceous ground cover data, Tables 2.7-23 through 2.7-25 show that the forest overstory is reproducing, thus indicating a generally stable situation at present.

Found on moist lower slopes, northern exposure or moist coves are the mesic mixed hardwood forests (sampling areas A, D, J, Tables 2.7-26, 2.7-27 and 2.7-28). White oak and red oak are the dominant species associated with slippery elm (Ulmus rubra), red maple, black walnut (Juglans nigra), American beech (Fagus grandifolia) and black gum (Nyssa sylvatica). These are floristically rich areas with many spring ephemerals found in the herbaceous ground cover. Abundant species include Virginia creeper (Parthenocissus quinquefolia), beggar's-tick (Desmodium sp.), greenbriar (Smilax sp.) and redbud seedlings (Cercis canadensis), the latter being an indicator of soils of limestone origin. These forests have an average canopy closure of 90 percent restricting the number of shrubby species.

NATURAL PINE AREAS

Three natural pine areas occur on Site in Areas C, G and H. These areas are shown in Figure 2.7-6; data for these areas are in Tables 2.7-29, 2.7-30 and 2.7-31, respectively. Area C, located near the center of the Site, is dominated by shortleaf and Virginia pines. The diameter at breast height (DBH) of these trees varies from 6 to 13 inches. Woody subordinate species including white ash (Fraxinus americana), southern red oak, yellow oak (Quercus muhlenbergii), hickory, red maple, flowering dogwood, black cherry (Prunus serotina) and Carolina buckthorn are scattered throughout. Much of the ground cover in this area forms dense mats. The most abundant species include Japanese honeysuckle (Lonicera japonica), poison ivy (Rhus radicans) and greenbrier (Smilax spp.). Of these, honeysuckle constitutes nearly 70 percent of the total with poison ivy and greenbrier comprising an additional two percent. Light intensity is relatively high in this area, compared to the pine plantation, due to a more open canopy. Consequently, a variety of herbaceous species are found here including ebony spleenwort (Asplenium platyneuron), Canada cinquefoil (Potentella canadensis), spotted wintergreen (Chimaphila maculata), bedstraw (Galium sp.), bush clover (Lespedeza sp.), rattlesnake plantain (Goodyera pubescens), Small's ragwort (Senecio smallii) and wild lettuce (Lactuca spp.).

Area G, located at the southern tip of the Site, north of Grubb Island Road, is predominantly composed of short-leaf and Virginia pine with invader species including eastern redcedar and deciduous hardwoods. Pine species in this area have a DBH equaling 6 to 13 inches. The deciduous understory includes red and white oak, red maple, redbud, American beech, black cherry, flowering dogwood, black gum and Carolina buckthorn. Ground cover species include Japanese honeysuckle, poison ivy, greenbrier, wild grape (Vitis rotundifolia) and Virginia creeper. Honeysuckle comprises the greatest percentage; however, the density of mat formation is less here than in Area C. One possible explanation for this may be that the age of Area G is less than that of Area C, thus, having less time for successional changes. The most abundant herbaceous species in Area G include goldenrod (Solidago sp.), white avens (Geum canadense) and bedstraw. Of these, white avens occurs most abundantly.

Area H, also located in the southern tip of the Site, is dominated by Virginia and shortleaf pine. It is a typical short leaf-Virginia pine forest with scattered openings supporting flowering dogwood, black cherry, redcedar, tulip tree, sweet gum and gray dogwood (Cornus racemosa). Understory is composed of Japanese honeysuckle, trumpet creeper (Campis radicans), poison ivy and greenbrier. The most prevalent ground covers, comprising nearly 45 percent of the total cover, include honeysuckle and trumpet creeper. Herbaceous species include anglestem (Actinomeris alternifolia), ebony spleenwort, sedge (Carex sp.) and wild strawberry (Frageria virginiana).

PINE PLANTATIONS

Two pine plantations, which were sampled on the Site, are located in Areas B and I as shown in Figure 2.7-6. Area B, a loblolly pine plantation planted in 1951, is located in the northern one-third of the Site, adjacent to the abandoned transmission line. This plantation is nearly a pure stand of loblolly pine with few subordinate species. Area I, found near the center of the Site, is dominated by white pine (*Pinus strobus*) but contains other pine species as well as hardwood saplings. The plantations are characterized primarily by a clay soil type with a relatively low pH concentration. In Area B, DBH averages 8 to 14 inches for most loblolly pines. Many of the white pines in Area I, listed in Table 2.7-32, range in DBH from 1.5 to 12.7 inches. Their annual growth appears to be 0.2 to 0.7 inches with terminal growth varying from 6 to 18 inches yearly. Hardwood subordinate species in both plantations include flowering dogwood, red maple, persimmon (*Diospyros virginiana*), sassafras, shortleaf pine, loblolly pine and tulip tree, listed in Tables 2.7-33 through 2.7-37. Average DBH of these species ranges from 1.5 to 6.5 inches. Ground cover in both areas is predominantly Japanese honeysuckle, poison ivy, Virginia creeper and blackberry (*Rubus* sp.). Herbaceous species are restricted to the plantations due to insufficient lighting resulting from a closed canopy and the extensive growth of honeysuckle. Japanese honeysuckle in these areas produces dense mats forbidding adequate germination of other species. In areas where the sun penetrates and honeysuckle growth is minimal, herbaceous species prevail. The most common of these include the crane-fly orchid (*Tipularia discolor*) and ebony spleenwort. Woody and herbaceous ground cover data for the white pine plantation Area I are found in Table 2.7-38.

CEDAR AREAS

One cedar community, Area E, occurs on the Site as shown in Figure 2.7-6. Data for Area E are presented in Table 2.7-39. This cedar glade area is located in the southwestern corner of the Site. Tree density is low allowing a nearly continuous ground cover of grasses and forbs. The dominant overstory species is eastern redcedar; the tree height ranges from 15 to 25 feet and the stem diameter from 3 to 8 inches. Few woody species other than eastern redcedar occur; however, herbaceous vegetation is more diverse. Bare soil and rock outcrops are frequent in this community.

MIXED HARDWOOD-CEDAR COMMUNITY

Community F, a relatively young successional hardwood forest, is dominated by eastern redcedar and mixed oaks. Vegetation here is dense forming extensive thickets of abundant saplings and a sparse ground cover being comprised mostly of Japanese honeysuckle. Area F is shown in Figure 2.7-6; data for Area F are presented in Table 2.7-40.

PLANT COMMUNITIES ON THE PROPOSED AND ALTERNATE TRANSMISSION ROUTES

Vegetation along the proposed and alternate transmission routes is discussed below; the transmission routes are discussed in depth in Section 3.9. The plant communities present along the routes as well as acres affected are discussed below and listed in Tables 2.7-41 and 2.7-42; the distinct cover types (community subdivisions) associated with certain community types are listed in Tables 2.7-43 and 2.7-44. The community types are descriptive classifications used to group the forest stands of similar character regarding composition and development due to ecological factors.[11,12] Lists of the woody species that occur within the transmission corridors may be found in Tables 2.7-45 and 2.7-46.

The proposed transmission corridor parallels the existing 161-kV transmission line from the CRBRP north to the 500-kV transmission line where it turns east following the 500-kV corridor on the south side to the existing 161-kV Ft. Loudoun transmission line. The alternate transmission corridor runs in common with the proposed route for 1.8 miles where it intersects an abandoned transmission right-of-way (ROW); at this intersection the alternate route follows the abandoned ROW to its intersection with the 161-kV Ft. Loudoun transmission line. The proposed and alternate routes assume a 150-foot wide ROW and will affect 58.2 and 61.8 acres, respectively.

Plant Communities Adjacent to the 500-kV Transmission Line -- Nine overstory community types and six associated understory community types comprise the 9.81 acre corridor adjacent to the existing 500-kV transmission line as can be seen in Table 2.7-41. Several of these communities are composed of multiple distinct cover types, as shown in Table 2.7-43.

The hardwood community type covers the majority of the corridor. About 50 percent of the overstory mileage and 75 percent of the woody understory mileage are of this deciduous type, as can be seen in Table 2.7-41. Along the 500-kV line the hardwood community is divided into six cover types. In the following discussion, these types are ranked in order of their predominance within the study area.

1. White oak-red oak-hickory -- This type and the next listed cover type are the most abundant hardwood cover types along the existing 500-kV line. White oak, red oak and hickory predominate. Common associates include American elm (Ulmus americana), winged elm (Ulmus alata), red maple, black walnut (Juglans nigra), basswood (Tilia americana), sweetgum (Liquidambar styraciflua) and blackgum. This climax cover type occurs on a variety of well-drained soils along the corridor.

2. Red oak-mockernut hickory-sweetgum -- With the previous type, this hardwood type covers a majority of the 500-kV line corridor. Red oak, mockernut hickory (Carya tomentosa) and sweetgum predominate. Associates are white oak, white ash, slippery elm, September elm (Ulmus serotina),

American elm, blackgum, red maple, silver maple, sugar maple, black walnut and black cherry. The type is subclimax to climax and occupies moist soils in and near stream bottoms.

3. Yellow poplar-white oak-northern red oak -- This cover type occurs commonly on moist sites along the 500-kV transmission line. On the wettest sites, however, it grades into the variant tulip poplar-white oak-blackgum-red maple type. Associated species are black oak, hemlock (Tsuga canadensis), blackgum and other hardwood species found in moist habitats. Its place in succession is not known.

4. Sweetgum-yellow poplar -- In this cover type sweetgum and tulip poplar predominate. It occurs on some of the moist lower slopes along the 500-kV line. Associated species are loblolly pine, red maple, white ash, green ash (Fraximus pennsylvanica) and other moist area hardwoods. The type may be near climax within the area.

5. Post oak-blackjack oak -- The post oak-blackjack oak cover type occurs in moderate amounts within the corridor. The most common associates of this type are the hickories. Other associates are southern red oak, white oak, scarlet oak (Quercus coccinea), blackgum, bitternut hickory, (Carya cordiformis), mockernut hickory (Carya tomentosa), red maple, winged elm, hackberry (Celtis sp.), Shumard oak (Quercus shumardi), dogwood and eastern redcedar. On the more moist sites in the study area the type is probably subclimax.

6. Scarlet oak -- This cover type occurs to a lesser degree within the corridor. Scarlet oak predominates, but black oak and southern red oak are coordinate associates. On the drier sites within the study area, the type grades into post oak-blackjack oak-black oak. Other associates are

chestnut oak, white oak, post oak, hickories, blackgum, sweetgum, sourwood, flowering dogwood, with occasional shortleaf and Virginia pines. The place of this type in succession is not clear, but it probably approaches climax on the drier sites.

A hardwood-natural-pine-cedar mixed community type occurs in overstory and understory associations along about 19 percent of the existing 500-kV line corridor as shown in Table 2.7-41. Eastern redcedar, shortleaf and Virginia pines, red and black oaks predominate. Associated species include hickories, American elm, sweetgum, dogwood and other hardwoods. Its place in succession is uncertain, but it is probably a temporary type which is succeeded by types of the oak-hickory group.

Naturally occurring pine stands cover about 11 percent of the 50 foot wide corridor adjacent to the existing 500-kV transmission line as shown in Table 2.7-41. This community type is divided into four natural pine cover types which occur along the line and which are listed in rank order of occurrence below.

1. Shortleaf pine-Virginia pine -- This cover type occurs on about one-third of the area that is occupied by natural pine stands and hence covers about four percent of the total area of the 500-kV corridor. Shortleaf pine and Virginia pine are pure or predominant. Associated with these species are hemlock, southern red oak, black oak, scarlet oak, white oak, post oak, blackjack oak, blackgum, sweetgum, chestnut oak and hickories. It is found on the drier sites and is spotty in distribution, not occupying extensive areas. It is succeeded by shortleaf pine and oaks.

2. Virginia pine -- Stands of pure or predominant Virginia pine cover a moderate amount of the area occupied by naturally occurring pines. Principal associations are

shortleaf pine, white oak, chestnut oak, southern red oak, black oak, sweetgum, red maple and blackgum. Loblolly pine is sometimes present. Virginia pine is a pioneer type that occupies dry sites. The type is temporary and will be succeeded by shortleaf pine and various hardwoods.

3. Loblolly pine-shortleaf pine -- This cover type occurs infrequently along the line. Loblolly pine and shortleaf pine predominate, usually with such associates as sweetgum, blackgum, hickories, hawthorn (Crataegus sp.), persimmon, southern red oak and post oak. The type is subclimax.

4. Loblolly pine -- Stands of pure or predominant loblolly pine occur to a very small degree along the line. Sweetgum is a characteristic associate along with shortleaf pine, southern red oak, post oak and blackjack oak. It is succeeded by mixtures of loblolly pine and hardwoods. The type also tends toward loblolly pine-hardwood following cutting.

Open community areas (areas having no overstory trees) comprise about eight percent of the corridor adjacent to the 500-kV transmission line as can be seen in Table 2.7-41. These areas are characterized by a diverse herbaceous ground cover and usually are rich in hardwood understory species.

The hardwood-natural pine community comprises nearly five percent of the 500-kV transmission line corridor as can be seen in Table 2.7-41. It occurs as two cover types.

1. Loblolly pine-hardwood -- This is the most predominant of the two hardwood-natural pine community cover types. Loblolly pine is not predominant but is the key tree making up at least 25 percent of the stand. It occurs on the drier sites with the associated species being southern

red oak, white oak (Quercus alba), post oak, northern red oak, hickories, shortleaf pine, persimmon and scarlet oak. It is probably a transitional type with succession toward the hardwoods.

2. Virginia pine-southern red oak -- This type occurs to a minor extent within the corridor. Virginia pine and southern red oak are predominant. Among the associated oaks are black oak, scarlet oak, white oak, post oak and blackjack oak. Associated also are shortleaf pine, blackgum and hickories. When present, the type occurs on the dry slopes and hilltops. It is probably a transition between Virginia pine and the hardwood climax.

Over three percent of the corridor adjacent to the existing 500-kV line is of the pine plantation community type as can be seen in Table 2.7-41. All of the plantations are composed of loblolly pines and most contain pole and saw timber sized trees from 10 to 14 inches DBH.

The hardwood-cedar community type comprises over two percent of the corridor, see Table 2.7-41. Eastern redcedar and several hardwoods including red and white oaks, hickories and black walnut predominate. The associated species are shortleaf, loblolly and Virginia pine, hackberry, ashes, winged elm, dogwood, blackgum and other hardwoods. This is thought to be a temporary community which is probably succeeded by some of the types of the oak-hickory group.

The pine plantation-cedar community covers just over one percent of the 500-kV line study area, see Table 2.7-41. Loblolly pine is the only plantation species, although eastern redcedar is liberally scattered within the overstory.

Natural pine-cedar community type comprises less than one percent of the 500-kV line study area, see Table 2.7-41. Eastern redcedar and Virginia pine predominate. The associates are numerous, but none is particularly characteristic. They include post oak, chestnut oak, red oak, red maple and dogwood. The community occurs on dry to moderately moist sites along the line. It is probably replaced by a pine-hardwood group.

Plant Communities Adjacent to the Abandoned Transmission Line -- Nine overstory community types and eight associated understory community types comprise the 23.33 acres within the two corridors along either side of the abandoned transmission line, as can be seen in Table 2.7-42. Several of these communities are composed of multiple distinct cover types listed in Table 2.7-44. The community types occurring along the abandoned line corridors are similar to those comprising the corridor adjacent to the existing 500-kV transmission line. Except for the pine plantation-cedar community type, which occurs only within the 500-kV line corridor and the cedar community type, which occurs only along the abandoned line corridors, reference should be made to the community descriptions in the previous section (Plant Communities Adjacent to the 500-kV Transmission Line) for descriptions of the communities occurring along the abandoned line. Communities, however, occur in different compositional degrees along the 500-kV and abandoned line corridors, Tables 2.7-41 and 2.7-42, and consequently a brief discussion of each community follows.

Natural pine community type comprises the majority of the abandoned line corridors. Nearly 38 percent of the overstory plant associations are of this type as shown in Table 2.7-42. The community is characterized by four distinct cover types: shortleaf pine-Virginia pine, Virginia pine, loblolly pine-shortleaf pine and loblolly pine as shown in Table 2.7-44. No natural pine type occurs in the understory.

The hardwood community type is second in abundance only to the natural pine community. It covers just over 17 percent of the abandoned corridor as shown in Table 2.7-42. A hardwood understory covers over 73 percent of the corridor. Six characteristic cover types of the hardwood community are: white oak-red oak-hickory, red oak-mockernut hickory-sweetgum, tulip poplar-white oak-red oak, sweetgum-tulip poplar, post oak-blackjack oak and scarlet oak, shown in Table 2.7-44.

Open community types are about twice as prevalent along the abandoned line as on the 500-kV line, comprising over 16 percent of the corridor, see Table 2.7-42. Open community types have either a herbaceous understory (non-woody), a herbaceous-hardwood understory ground cover or a seedling loblolly pine plantation understory community type. Areas with no woody understory occur on over six percent of the abandoned corridors mainly within the open community type, but also to a degree within the pine plantation community type. No herbaceous understory community type occurs along the 500-kV line.

Nearly 13 percent of the abandoned line corridor is composed of loblolly pine plantations as seen in Table 2.7-42. Pines in these plantations are about 50 to 70 feet high and are from 10 to 14 inches in DBH. An additional 3.5 percent of the corridors are seedling loblolly pine plantations classified as an understory community type.

A mixed hardwood-natural pine-cedar community type occurs on nearly five percent of the abandoned line corridor. It is a temporary successional type found in patches of limited extent in eastern Tennessee and probably southward into adjoining states.

The natural pine-cedar community comprises about four percent of the abandoned line corridors. It occurs quite generally in this southern part of the Central Forest region, but will probably be replaced by a hardwood-pine type.

Mixed hardwood-cedar community type occurs on about 3.4 percent of the area within the abandoned line corridor.

Hardwood-natural pine mixed community type comprises over two percent of the abandoned line corridor. The community is divided into two distinct cover types which are loblolly pine-hardwood and Virginia pine-southern red oak shown in Table 2.7-43.

A pure eastern redcedar glade occurs on about 1.5 percent of the abandoned line corridor but does not occur along the 500-kV line corridor as shown in Table 2.7-44. Eastern redcedar and pine seedlings comprise the understory vegetation. This is a temporary type and is succeeded by various hardwood types.

2.7.1.3.2 SUCCESSIONAL TRENDS

Potential natural vegetation of the Clinch River region including the CRBRP Site is Appalachian oak forest[13] as best illustrated by community types A, D, K and L. Given sufficient time, disturbed areas will tend toward these community types even though site conditions such as shallow soil and topographic position may prevent development of such oak forests. The degree of disturbance substrate and available seed sources largely control the rate of successional changes in a given region.

Successional changes involve gradual replacement of early successional species by those able to tolerate the environmental conditions resulting from their presence. When the existing species successfully reproduce in such conditions, the community is termed climax whether or not its composition corresponds to the potential regional vegetation. Ridgetops, by virtue of shallow rocky soil and the tendency of nutrients to move downslope, will have slower rates of succession than valley floors which tend to have deep soils and nutrient enrichment from upslope. The cedar glades occur on shallow soil developed from shale or siltstone and appear to be a climax community as a result of shallow, droughty soil conditions.

Successional pine communities such as Area H will develop into pine forests, as Area C, with a hardwood understory and eventually into oak forests. Pines and eastern redcedar may successfully reproduce on ridgetops in the climax community. Area F, a young oak forest, will eventually develop into a mature oak forest as in Area D. Shortleaf, Virginia and loblolly pine plantations will rapidly change to hardwood pine communities and more slowly to hardwood communities. White pine plantations, as a result of low light intensities beneath the canopy, will more gradually go through the same sequence of changes. Data in Tables 2.7-32 through 2.7-38 support these successional sequences.

2.7.1.3.3 UNIQUE VEGETATION AREAS

Unique vegetation areas within ten miles of the Clinch River Site include the University of Tennessee Arboretum near Oak Ridge, a nearly pure stand of sassafras near the Dosimetry Application Research Facility Reactor (DOSAR) at X-10 and a stand of eastern redcedar near the University of Tennessee Agricultural Farm.[9]

Jones Island, located at Clinch River Mile (CRM) 20 approximately two miles upstream from the Site, has a total of 40 acres being used for genetic studies and breeding and physiology projects associated with plants. Research includes pollination and seedling plant studies.[9]

Each "natural area" on Site, as shown in Figure 2.7-6, was examined working from the definition of a natural area as any climax community that is ecologically unusual in terms of extent or occurrence.

The formerly designated natural area (Type 26 in Figure 2.7-6) on the peninsula in the northwest corner of the Site contained extensive disturbance in the center of the community from past cultivation and a copious growth of Japanese honeysuckle, a non-native vine species. The dominant species include sycamore (<u>Platanus occidentalis</u>), American Elm and Boxelder (Acer negundo) with willow (Salix nigra) and cottonwood (Populus deltoides) adjoining the intermittently flooded borders of the peninsula. Because such areas are quite common in the region and because of the disturbed nature of the community, removal from the status of "natural area" is warranted.

Area A, as shown in Figure 2.7-6, the red oak-tulip poplar-white oak natural area, qualifies as a natural area only in part. The southern portion is of such quality that it deserves designation as a natural area; however, the narrow, northern neck of the community does not deserve to be called a natural area due to cutting disturbances and influences of neighboring communities. The cedar glade found in Area E is a climax community of cedar with overstory species reaching heights of 30 to 40 feet. Regionally this community is relatively uncommon and deserves the natural area designation.

The old growth beech-maple and beech-mixed oak areas (Areas L and L', Figure 2.7-6) represent a climax community of particularly good quality. This community has reached its self-perpetuating stage of succession and is in equilibrium with the habitat. This area might well be expanded to include adjacent portions of Area K--particularly the northfacing slope in the northeastern portion of K. The community (Area L) is so narrow that its distinctive flora may well be jeopardized unless the community upslope (Area K) remains undisturbed. Area L contains many uncommon spring ephemeral plant species that require cool, humid environmental conditions. Removal of trees in Area K and the logging roads required for such removal would increase erosion downslope, increase temperatures and light intensities and decrease humidity, endangering survival of the spring ephemerals. Preservation of portions of Area K is desirable to maintain the unique character of Areas L and L'. The desired protection can be afforded Areas L and L' by the establishment of a 500-foot buffer zone surrounding those areas.

2.7.1.3.4 PLANT SPECIES OF SPECIAL IMPORTANCE

In a phenological study of 225 species of vascular plants in the Oak Ridge area, Taylor classified 18 of the species as considered rare, of special interest, or of limited distribution within the Oak Ridge Reservation.[14] Relative abundance of the plants in this study is listed as common, frequent, occasional and rare. One of those species identified by Taylor as occurring occasionally within the Oak Ridge Reservation is found on the Site. The hoary puccoon (*Lithospermum canescens*) occurs on the Site in abundance along Grubb Island Road on the boundary of Area 35. A search for additional populations of this species is being continued.

To date, only one species which might be categorized as rare or endangered has been collected and tentatively identified as black snakeroot (*Cimicifuga rubifolia*), formerly described as *Cimicifuga americana* var. *cordifolia*. The known species' range is indicated in Figure 2.7-7. Black snakeroot was found on site in Area L, shown in Figure 2.7-6, at the base of the northwest facing slope where the slope breaks into the small flood plain of Grassy Creek.[15] Site requirements of this species are calcareous soils of mesic sites that have undergone minimal modification. It is quite susceptible to disturbance as evidenced by its absence in successional fields in the same area.

2.7.1.4 WILDLIFE

A variety of vegetative communities, primarily woodland, on the Site provide varied habitat for many wildlife species. Many communities found on the Site are typical of eastern Tennessee, an area rich in flora and fauna. Sampling methods are discussed in Section 6.1.

Mammals, avifauna, herpetofauna, invertebrates and unique, threatened or endangered species are considered in this section. Scientific names of all species not indicated in the text are included in Tables 2.7-47 through 2.7-59.

2.7.1.4.1 MAMMALS

Each of the diverse habitats found on the Site is utilized by a number of mammalian species. Mammal distribution and abundance on the Site are affected by soil, topography, vegetation and the presence of water. The greatest diversity of species occurs in the mixed hardwoods and hardwood-cedar-pine association while the lowest diversity occurs in the pine plantations.

Studies completed by ORNL in the Oak Ridge area and particularly in the Melton Valley area can be utilized to characterize the mammal species of the Site.[16,17] While the Melton Valley area is not within the Site boundaries, the close proximity of this area (four to seven miles) and the similarity of habitat permits the utilization of data for characterization. In addition, qualitative investigations of mammals are currently being conducted on Site as well as quantitative analysis of small mammals, shown in Table 2.7-47. Table 2.7-48 is a compilation of data from these several sources.

<u>Big game</u> -- White-tailed deer (<u>Odocoileus virginianus</u>) are the only big game animals commonly occurring on the Site. Although this animal is the most important big game mammal of eastern United States it should be noted that hunting is not permitted on the Site. Deer occur throughout the area (based on 1974 visual sightings and tracks). They prefer the hardwood-pine forests and ecotones such as the overgrown abandoned transmission line which provides preferred browse. Within its home range, usually one to two square miles, the deer feeds on twigs, shrubs, fungi, acorns, grass and herbs.

This area is probably outside the range of the black bear (Ursus americanus) which occurs in the mountainous areas of extreme eastern Tennessee. The lack of sightings or observations suggests that the species does not occur on the Site.

Small game -- Two of the most important small game species occurring on the Site are the eastern cottontail (Sylvilagus floridanus) and the eastern gray squirrel (Sciurus carolinensis). Of the two species, the squirrel is more abundant. Cottontails occur throughout the Site but primarily near old fields, open areas (transmission lines) and edge areas. Foods of the cottontail include green vegetation in summer and bark and twigs in the winter. Gray squirrels are found in more mature deciduous woodland areas where they feed on nuts, acorns and seeds.

Furbearers -- This general category may be broken down into three groups: predators, omnivores and aquatic species.

The red and gray fox (Vulpes fulva and Urocyon cinereoargenteus, respectively) are the most common predators on the Site. Based on data from nearby areas, it is expected that the red fox population density is larger than that of the gray fox.[16] Both species occur throughout the Site. Although bobcats may occur on the Site, their presence has not been recently documented and no primary or secondary indications of their occurrence have been thus far observed. The foods of these mammals are primarily small animals, although foxes may ingest other items such as insects, fruits or eggs.

Opossum (Didelphis marsupialis), raccoon (Procyon lotor) and striped skunk (Mephitis mephitis) are omnivores common to the Site which are often found near water but may also roam throughout wooded areas. Presence of the raccoon was documented by sitings during recent surveys. Spotted skunks may also occur in habitats similar to those on the Site.[18] They prefer brush habitat and edge areas along stream banks and rivers.

Aquatic species such as muskrat (Ondatra zibethica) and mink (Mustela vison) occur along the Clinch River. Muskrats have generally been found to be more numerous than mink.[16] Food utilized by the muskrat is primarily aquatic vegetation, while the carnivorous mink eat both aquatic and shoreline animals. Muskrats are included among the prey of the mink.

Small mammals -- Small mammals on the Site may be divided into two groups, insect eaters and rodents.

The short-tailed shrew (Blarina brevicauda) is the most common insectivorous mammal occurring throughout the major habitat types. This species was captured in the hardwood and coniferous forests in Study Areas K and C, respectively, shown in Figure 2.7-6. It was reported to occur in large numbers in nearby areas as well.[16] The smoky shrew (Sorex fumeus), southeastern shrew (Sorex longirostris) and eastern mole (Scalopus aquaticus) are other insectivores which may occur on the Site; however, no actual sitings were made of these species.

Woodchucks (Marmota monax) are the largest rodents on Site. This species feeds on herbaceous vegetation and burrows in wooded areas or near road shoulders or openings.

The eastern chipmunk (Tamias striatus) was also observed during current Site surveys. This small omnivore inhabits deciduous hardwood forests and brushy areas.

Small rodents most commonly occurring on the Site are the white-footed (Peromyscus leucopus) and the golden mouse (Peromyscus nuttalli). White-footed mice prefer wooded or brushy areas while golden mice favor the forest, particularly areas with honeysuckle growth. During late winter and spring 1974 surveys, five white-footed mice were captured in Study Area K, one in the conifer forest in Study Area G and two in the conifer forest in Area I, as can be seen in Figure 2.7-6. During the same survey period one golden mouse was captured on each of the conifer forest study areas H, G and I. The only preliminary population estimation made for this survey period was 2.33 white-footed mice per acre for Study Area K. Additional data are currently being collected to estimate the populations on the remaining study areas. The first two Site surveys for 1974 represent a total of 1,000 live-trap nights and 450 snap-trap nights. Other small rodents which may occur on the Site include the eastern harvest mouse, rice rat, hispid cotton rat, pine vole, Norway rat and house mouse.

Other Mammals -- Several bat species, listed in Table 2.7-48, may occur on the Site. Studies are currently under way to determine their presence.

2.7.1.4.2 AVIFAUNA

The Clinch River Site provides excellent habitat for many avifauna species[19] as shown by two surveys conducted in March and May, 1974. Both surveys were directed toward locating the greatest population densities and species diversification within the site border. Eleven major habitat types, shown in Figure 2.7-6, were surveyed critically, while general observations were made on areas other than the above. All avifauna species observed during both surveys are listed in Table 2.7-49. To supplement this list, a total list of avifauna species adapted from a previous list prepared by ORNL for the Oak Ridge Reservation appears in Table 2.7-50.[20] Many of the species listed there correlate with those in Table 2.7-49, the major exception being waterfowl. It is expected that continuing surveys will provide additional waterfowl data which will more closely correlate with the ORNL list. Additional studies completed for ORNL provide information pertaining to avifauna species present on the Oak Ridge Area.[21,22]

Upland Game Birds -- Four species of upland game birds were found on Site. The most preferred habitat for these individuals appeared to be mixed oak woods and borders of old fields and woodlots.

Bobwhite quail (*Colinus virginianus*), a popular game bird in the southeast, is the most abundant upland game species throughout the Site. Bobwhite prefer brushy fields, abandoned farms and open pine woods. They eat a varied diet of leaves, buds, fruits, seeds, insects and snails. Many individuals were observed in open fields and brushy habitat.

Ruffed grouse (*Bonasa umbellus*), a woodland gamebird, was found to occur throughout the mixed oak woods. Grouse prefer hardwood and brushy cover, using conifers in winter and abandoned fields and orchards through the remainder of the year. The adult's diet is almost exclusively vegetarian, consisting of fruits, leaves and buds.

Many mourning doves (*Zenaidura macroura*) were observed in flight throughout the Site area. This migratory game bird is especially important in the southern United States. It forages in fields, orchards and open areas, feeding primarily on weed seeds and waste grain.

The American woodcock (*Philohela minor*) is a common upland game bird in the eastern United States. It prefers wooded swamps, alder thickets and moist bottomlands. Earthworms constitute the major portion of its diet. Males utilize grassy openings for spring courtship displays. Individuals were found abundantly along borders of wet fields and woodlots during the May survey.

Waterfowl -- Few waterfowl species were found on Site. All species encountered were observed along the Clinch River. This river system is utilized by waterfowl during migratory periods of early spring and late fall.

The Canada goose (Branta canadensis), the most widely distributed of North American waterfowl, is a winter visitor throughout much of the United States. Migrating birds rest and feed on marsh vegetation, or graze on young plants and waste grain in nearby fields. The flock uses the Clinch River as a travel corridor and most likely will cross the CRBRP Site near the reactor building.[23] Two individuals were observed on the Clinch River during the May survey.

A common waterfowl resident of freshwater lakes and ponds is the American coot (Fulica americana). They construct their nests in reeds and gather a diet of aquatic vegetation, insects, snails, tadpoles and small fish. Four coots were observed on the Clinch River.

Wood ducks (Aix sponsa), a common resident of the eastern United States, were found to be the most abundant waterfowl species on the Site. They nest in tree cavities near wooded river bottoms or forested stream banks. Wood ducks eat acorns, aquatic vegetation, dogwood fruits and other plant parts gathered in the water and woodlots.

Raptorial Birds -- Among the raptorial birds, the most commonly observed species include the black and turkey vultures (Coragyps atratus and Cathartes aura, respectively). Both species are proficient in catching thermal updrafts and soaring for miles in search of carrion, their primary food source. Although common on Site, the black vulture is generally restricted to more southern areas of the United States. Many individuals of both species were observed in flight over all vegetation types.

Another common raptor of eastern North America, the red-shouldered hawk (Buteo lineatus), nests in moist woodlands and feeds in forests and edge areas. Small rodents, insects, songbirds and amphibians comprise most of its prey. Both species, the red-tailed (Buteo jamaicensis) and red-shouldered, were observed in flight over fields and mixed oak woods.

Broad-winged hawks (Buteo platypterus) are also common throughout the eastern United States. This species is the smallest of the soaring hawks present on Site. It generally hunts from a perch, capturing and eating small rodents, insects, amphibians and reptiles. This species was observed in flight along the Clinch River and borders of old fields and transmission lines.

The American osprey (Pandion haliaetus) was observed along the Clinch River on May 4, 1974. Its diet is largely composed of fish. Much of its morphological anatomy is adapted to grasping, carrying and eating fish. The nest is a bulky structure made of sticks and often constructed in dead trees. In recent years, pesticide accumulations throughout the foodchain have been the single most important factor for its decreasing population.

Cooper's hawk (Accipiter cooperii) is an uncommon "bird hawk" of open woodlands and wood margins. It is a swift flier and feeds on game birds, songbirds and small rodents. Several were observed in flight over mixed oak woodlots.

In many areas, sharp-shinned hawks (Accipiter striatus) are more commonly observed than the Cooper's. They hunt in open woodlots and edge areas. These hawks kill and eat a variety of small songbirds up to the size of pigeons and occasionally take mice and insects. They were observed in flight over mixed oak woods.

A large raptor, the great horned owl (Bubo virginianus), is common in forests and woodlots, especially near farmlands. It searches at night for its prey, which include cottontail rabbits, skunks, rats, other small mammals and insects. A single individual was heard calling in a mixed oak woodlot habitat.

Barred owls (Strix varia) are residents of dense woodlands, swamps and river bottoms. They nest in tree cavities or appropriate abandoned nests of other large bird species. These owls hunt at night for mice, frogs, lizards and insects. One individual was heard calling along an edge area of an old field and woodlot.

The Screech owl (Otus asio) is a small species found in woodlots, orchards and towns. It feeds extensively on insects and occasionally eats mice, crawfish, amphibians and small fish. Several individuals were heard calling after dark along borders of wooded areas and old fields.

Of the eleven major habitat types (vegetation types), the one occupied by the most avifauna species (64 species) appeared to be a mixed oak forest association (Locations A, D, F, J, K; Figure 2.7-6 and Table 2.7-51). Areas such as these are predominantly composed of white and red oak, American beech, hickory and maple species and show much stratification with many suppressed and intermediate saplings. These varied habitats provide excellent cover for many avian species.

Wood warblers (Dendroica spp.) appear to be most abundant in the tree tops with thrushes (Hylocichla spp.) occupying the lower vegetation zones and forest floor. Of the warblers, the bay-breasted (D. castanea), Kentucky (Oporornis formosus), hooded (Wilsonia citrina) and magnolia (D. magnolia) appeared most abundant, while, in the case of the thrushes, the wood (H. mustelina) and Swainson (H. ustulata) were most abundant. Other species commonly observed here are listed in Table 2.7-50.

Border areas (fields or transmission lines adjacent to woodlots) appeared to be the second most preferred habitat for avifauna. Preference for these areas appears to be only slightly lower than areas within the mixed oak woods (six species as compared to five). The most abundant species in these areas include: the Carolina wren (Thryothorus ludovicianus), Carolina chickadee (Parus carolinensis), indigo bunting (Passerina cyanea), tufted titmouse (Parus bicolor) and rufous-sided towhee (Pipilo erthrophthalmus). In areas containing conifer species, the most abundant avifauna species appeared to be the pine (Dendroica pinus), prairie (D. discolor) and magnolia (D. magnolia) warblers. All avifauna species found along such borders are included in Table 2.7-52.

The third most preferred habitat for avifauna was old fields and open areas (Locations G and H; Figure 2.7-6). Here, the numbers of species were found to be relatively low. Most of the commonly observed species found in open fields include the song (Melospiza melodia), a field (Spizella pusilla) and chipping (S. passerina) sparrows, red-winged blackbird (Agelaius phoeniceus) and indigo bunting. A complete list of all avifauna observed in these areas appears in Table 2.7-53.

Cover types associated with aquatic habitats comprised a fourth major avian community (30 species). Here, the yellowthroat (Geothlypis trichas), yellow-breasted chat (Icteria virens), Carolina wren, white-eyed vireo (Vireo griseus), red-winged blackbird and song sparrows were most commonly observed. These species are listed in Table 2.7-54.

Pure conifer and predominantly conifer areas were least preferred by avifauna (Locations E, G, H, I, L; Figure 2.7-6). The number of avifauna species (19) in these areas were extremely low. Even when surveyed during early morning hours (a period when song and call is usually maximum) few individuals could be heard. Here, the most common species appeared to be the pine warbler and the white-throated sparrow (Zonotrichia albicollis) as can be seen in Table 2.7-55.

The most commonly observed avian species on the Site are included in Table 2.7-56.

2.7.1.4.3 HERPETOFAUNA

The Site provides a rich and varied habitat for many herptile species present throughout the Oak Ridge area. Rocky ledges, honeysuckle thickets, small ponds and intermittent streams, present on Site, are preferred habitats for such animals.[24,25]

Herpetofauna were surveyed on the Site in mid-May using calls and field collections. Collections were made in eleven of twelve vegetation types sampled, shown in Figure 2.7-6, to characterize the species common to each vegetation type. Relative abundance of all species observed is indicated in Table 2.7-57. General observations and collections were made on all areas other than the above including: ponds, intermittent streambanks, roadsides, fields and ecotones between vegetation types.

A majority of herptile species show a home range preference to mixed oak forest associations. Here vegetative stratification and diversity of plant species provide a variety of herpetofaunal habitats. Ponds, streams and creekbanks contain the greatest variety and density of frogs (*Rana* spp. and *Hyla crucifer*), while moist ravines were most preferred by salamanders (*Plethodon glutinosus*). A small pond south of Area D, shown in Figure 2.7-6, contained ten green frogs (*Rana clamitans*), one pickerel frog (*Rana palustris*) and one spring peeper (*Hyla crucifer*).

The second most preferred habitat type appears to be roadsides and old fields. Here the diversity of species appears greatest on warm, sunny days. The most abundant species in this habitat was the eastern fence lizard (*Sceloporous undulatus*).

In contrast to the above vegetation types, predominantly pine or pine-cedar habitats contain the fewest herptile species. The only herptile species collected or observed here was the black racer (Coluber constrictor). Other species observed on the reservation by ORNL groups up to 1964 and potentially occurring on the Site are listed in Table 2.7-58.[26]

2.7.1.4.4 INVERTEBRATES

A list of forest invertebrates identified on the Oak Ridge Reservation appears in Table 2.7-59.[27] While those species may not have been specifically identified on the Clinch River Site, this list is representative of species located there. No detailed studies of invertebrate fauna are being undertaken on the Site because ORNL data provide adequate characterization.[27]

Terrestrial invertebrates contribute to the functioning of terrestrial ecosystems. Insects for example provide beneficial as well as detrimental effects on any ecosystem. As a benefit, they provide food for higher trophic levels and assist with organic decomposition and mineral release. Detrimentally, insects consume vegetation and may transmit plant and animal disease.

Insect species can usually be identified by effects produced on the host. The larva of the southern pine beetle consumes portions of shortleaf pine apical buds resulting in decreased tree growth or tree death in severe infestations. Many of the shortleaf pine stands on Site contain infestations of this beetle.[3] The extent of infestation is being documented during the monitoring program.

2.7.1.4.5 THREATENED OR ENDANGERED OR UNUSUAL AND SIGNIFICANT SPECIES

Thus far two faunal species listed as endangered or threatened by the United States Department of the Interior[28] have been observed on Site. A literature review indicates that five additional threatened or endangered species have the potentiality of occurring there.[28,29,30] However, each of these threatened or endangered species is widely distributed in the Tennessee area.

Other faunal species present on the Site may be considered unusual and significant; that is, species occurring in relatively low numbers on Site but not considered threatened or endangered by U. S. Bureau of Sport Fisheries and Wildlife.[28]

Mammals -- Probably the only endangered mammal species which may occur on the Site is the Indiana bat (Myotis sodalis). This bat inhabits caves in winter and man-made structures or hollow trees in summer.[18] A complete cave search in August indicated the absence of the Indiana bat from the Site even though it does occur in the general area. Species less likely to utilize the Site include the endangered eastern cougar (Felis concolor cougar) and the Florida panther (Felis concolor coryi). No on-site primary or secondary evidence has indicated the presence of any of these species.

Avifauna -- On May 14, 1974, a southern bald eagle (Haliaeetus l. leucocephalus) (endangered) was observed on Site near the Clinch River. The diet of this bird is 99 percent fish. It nests in large trees and utilizes the same nest year after year. The nests are primarily located in estuarine areas along the Atlantic and Gulf coasts, from New Jersey to Texas, lower Mississippi Valley southwest from eastern Arkansas and Western Tennessee and through the southern states west to California and Baja California.[28] Possible reasons for its population decline include: illegal shooting, loss of natural habitat and limited reproduction success due to pesticide uptake by adults. No nest was observed on Site and from all indications, the individual observed appears to be an immature migrant.

On May 4, 1974 the American Osprey (Pandion haliaetus) (status undetermined) was observed catching fish and carrying its prey to a pinnacle on the opposite shore of the Clinch River. The American osprey breeds from northern Alaska south to Baja California and Sonora, east to southern Labrador, Newfoundland and southern Florida. It winters from southern United States south to South America.[28]

Other species considered endangered or with an undetermined status which have potential of occurring on Site include the red-cockaded woodpecker (Dendrocopos borealis, endangered), peregrine falcon (Falco peregrinus, endangered)[29] and eastern pigeon hawk (Falco c. columbarius, status undetermined).

Avifauna species occurring on Site which may be considered unusual and significant to the area include the prothonotary warbler (Protonotaria citrea), Cooper's hawk (Accipiter cooperii) and sharp-shinned hawk (Accipiter striatus).[27] All three species were observed during the May 1974 survey. The Golden eagle (Aquila chrysaetos), although not actually observed, may be considered unusual and significant if present.

Herpetofauna -- On-site surveys and a literature review failed to indicate the presence of any herpetofauna species considered endangered or threatened by the United States Department of the Interior.

2.7.1.5 IMPORTANT DOMESTIC ANIMALS

Beef cattle, dairy cows, hogs and milk-producing goats are an important part of man's food chain. Therefore, a census survey was conducted on May 1 and 2, 1974, to determine the number and location of these species within a 10-mile radius of the Site. For the main survey area, the region surrounding the plant was divided into sixteen 22-1/2° azimuthal sectors with inner radial increments of 1, 2, 3, 4 and 5 miles as illustrated in Figure 2.7-8. Although most of the area covered during the survey lies within Roane County, small portions of Loudon, Anderson, Morgan and Knox Counties were also included up to a radius of 10 miles from the plant Site.

The total area surveyed is dotted with small farms each of which usually has a few beef cattle and one or two dairy cows. Approximately 70 farms were visited to determine the number of cattle and dairy cows grazing in the fields. Presence of hogs and goats were also noted. Results of the survey are shown in Table 2.7-60.

Less than 20 hogs and only two goats were seen during the survey. A total of 858 beef cattle and 63 dairy cows were identified and tabulated within the 10-mile radius of the Site. Within five miles of the Site, the total numbers of beef cattle and dairy cows tabulated were 475 and 61, respectively.

Since all of Roane County was included in the survey, results could be easily compared with published data. According to a 1969 Census of Agriculture conducted by the Department of Commerce, Bureau of Census,[31] a count of 483 farms in Roane County showed an inventory of 11,828 beef cattle and calves; 120 farms showed an inventory of 1,129 milk cows. This census also showed a total inventory of 2,281 pigs for Roane County. The number of goats in the area was not reported. A survey of farms in Roane County identified 801 beef cattle and 61 dairy cows on approximately 65 farms. These numbers represent approximately one-half as many beef cattle and dairy cows as were reported in the census. The ratio of dairy cows to beef cattle reported in our survey (12.7 to 1) is approximately the same as that reported in the census (10.5 to 1).

2.7.2 AQUATIC ECOLOGY

2.7.2.1 INTRODUCTION

The CRBRP Site is located on a peninsula bounded on three sides by the Clinch River between river miles 15 and 18. Headwaters of the Clinch River are in Tazewell County, Virginia and from there, the river flows southwesterly for 350 miles, draining an area of 4,413 square miles. Confluence of the Clinch River with the Tennessee River occurs at Tennessee River Mile (TRM) 567.8 near Kingston, Tennessee. Emory River, a major tributary of the Clinch River, has a drainage area of 865 square miles and joins the Clinch River at Clinch River Mile (CRM) 4.4. Caney and Poplar Springs Creeks are two minor tributaries, having drainage areas of less than 10 square miles, which enter the Clinch River from the south at CRM 17 and CRM 16.2, respectively.

At the CRBRP Site the Clinch River ranges approximately 300 to 600 feet in width and is part of Watts Bar Lake which is formed by Watts Bar Dam at TRM 529.9, about 55 river miles downstream from the Site. Flow and water level of the Clinch River at the Site are highly regulated by the operations of TVA dams. Water level at the Site is basically controlled by Watts Bar Dam. A smaller dam, Melton Hill Dam, located approximately fives miles upstream from the Site at CRM 23.1, was put into operation in May 1963. Water flow past the Site is most immediately influenced by the operation of Melton Hill Dam; however, the primary regulator of flow is Norris Dam located at CRM 79.8. Water level at the Site has a normal range of approximately six feet during the year and the flow velocity is highly variable. Periods of zero flow in the Site area have been recorded during the baseline surveys and upstream (reverse) flows have been postulated, as stated in Section 2.5.

An annual average flow of approximately 4,800 cfs at the Site is calculated from the records of Melton Hill Dam average monthly discharges from 1964 through 1973, as shown in Table 2.5-3. Watts Bar Reservoir elevations are indicated in Table 2.5-5. Average monthly water temperatures at CRM 21.6 are available for the years 1963 to 1971 and are shown in Table 2.5-7.

Water quality of the Clinch River is not significantly affected by present municipal and industrial waste discharges. Some water quality data[32] are available for the Clinch River for the period covering June 1967 to April 1968 at two monitoring stations at CRM 79.8 and 23.1 and are presented in Table 2.7-61. Additional non-radioactive water monitoring data taken at the Oak Ridge Gaseous Diffusion Plant pumping station[33] at CRM 14.4 for 1971 and 1972, are presented in Tables 2.7-62 and 2.7-63. Further details on water quality are given in Section 2.5. Three industrial water supplies in close proximity to the Site use Clinch River surface water as a source of potable water. The nearest of these is located 1.6 miles downstream from the Site at CRM 14.4. Surface water uses of the Clinch River are discussed in Section 2.2.

2.7.2.2 PREVIOUS ENVIRONMENTAL STUDIES

Previous environmental studies of the Clinch River in the vicinity of the CRBRP Site have been performed primarily by the Tennessee Valley Authority (TVA) and the Oak Ridge National Laboratory (ORNL). Most of the data from these previous studies are of limited value to the present-day characterization of the physical and chemical parameters and biological communities of the Clinch River at the CRBRP Site because: (1) data collected are not site-specific; (2) data were collected prior to construction of Melton Hill Dam; and (3) data were mainly of a qualitative nature. Results of biological surveys[34,35,36] performed on the Clinch River are available with reference to the Bullrun and Kingston Steam Plants, at CRM 47.5 and 2.7, respectively.

Pertinent data from previous studies are mentioned in following sections and used for purposes of comparison or as information supplementary to the data obtained from the present baseline survey.

2.7.2.3 PHYSICAL AND CHEMICAL PARAMETERS

Discussed in the following sections are specific physical and chemical parameters which help to characterize the Clinch River at the Site. Methods and procedures used for the aquatic baseline survey are described in Section 6.1. Since the baseline survey is only partially complete, the observations and conclusions made in the following sections are based on the results of six major field trips (March 25 to 29, May 29 to June 4, June 24 to 28, July 22 to 26, August 26 to 29 and September 23 to 26).

2.7.2.3.1 LOCATIONS OF SAMPLING STATIONS

In the following sections, references are made to sampling stations used for physical and chemical parameters. Locations of these stations are illustrated in Figures 6.1-2, 6.1-4 and 6.1-9. Arrangement of sampling stations are also described in Section 6.1.

2.7.2.3.2 BATHYMETRY

Bathymetric charts and illustrations showing cross-sectional bottom profiles of the Clinch River for the intake and discharge areas are presented in Section 2.5 as Figures 2.5-5 through 2.5-8. In the study area, CRM 15 to 18, the shorelines are moderately steep. During periods of high water, tree branches and other vegetation are partially submerged or overhang the edges of the river and form dense cover along most sections of the river edges.

There are midriver sand-gravel bars from approximately CRM 15.6 to 16.1 where the river widens to about 600 feet. During a preliminary reconnaissance field trip (February 26 to March 1, 1974) these bars were partially exposed between CRM 15.7 and 16.0. On February 27, 1974, at a river water level of roughly 736 feet, the exposed portions of the sand bars measured approximately one and one-half to two feet above the water surface. The largest exposed bar measured 520 feet in length by 98 feet in width. The location of the bar, relative to the discharge, is shown in Figure 2.5-6.

2.7.2.3.3 RIVER HEIGHT

Water levels were recorded from readings made of the stadium staff at CRM 16.5 during all field trips from March 25 through September 26, 1974, and are shown in Table 2.7-64. Water levels varied by 6 feet 2.0 inches. The lowest reading, 736 feet 9.5 inches above mean sea level (MSL), occurred on March 29, 1974 and the highest reading, 742 feet 11.5 inches MSL, occurred on July 25, 1974. At a river elevation of 737 feet MSL, the greatest depth of the river between CRM 15 and 18 ranges from 16 to 26 feet.

2.7.2.3.4 WATER VELOCITY AND CURRENT DIRECTION

Water velocity and current direction were measured in the vertical water column at the sampling locations shown in Figure 6.1-4 on all trips. In addition, measurements were made inside of Caney and Poplar Springs Creeks in May, June, August and September. Results are included in Tables 2.7-65 through 2.7-70.

Analysis of the water velocity data is complicated somewhat by the fact that velocities on the river can be altered rapidly by changes in the discharge rates of the dams affecting the Clinch River. A good example of this is seen in the June trip data, as shown in Table 2.7-67, where water velocity increased from a range of 0.1 to 0.3 feet per second at Transect 1-Station 7 to a range of 2.4 to 2.9 feet per second at Transect 2-Station 3, which was sampled approximately 15 minutes after Transect 1-Station 7.

Velocities at Station 7 of Transects 2 and 3 were seen to be of small magnitude, even when velocities at Stations 3 and 5 of these transects were relatively great. These two stations are located in the mouths of Caney and Poplar Springs Creeks. Net flow was into the creeks on the March, June, August and September field trips. In May, net flow was out of the creeks. In July, net flow was into Caney Creek, but out of Poplar Springs Creek. Whether net flow is into or out of the creeks is most likely primarily determined by whether the river level is rising or falling at the time the measurement is made. It is noted that in the June data, current direction is into Caney Creek at its mouth (Transect 2-Station 7), but a measurement made inside the creek shows current to be flowing out of the creek. This is most likely due to an eddying effect at the sampling station inside the creek.

2.7.2.3.5 TEMPERATURE

Water temperatures at all sampling stations shown on Figure 6.1-4 were measured through the vertical water column. Lowest values were seen in March, when they ranged between 51.4 degrees F and 52.5 degrees F. Highest values consistently over 70 degrees F were seen in August, Tables 2.7-65 through 2.7-70. There are no apparent significant differences between sampling stations, except the stations inside Caney and Poplar Springs Creeks and Station 7 of Transects 2 and 3 in the mouths of the creeks. These stations often show temperatures higher than those at the other stations. This effect was most notable at the surface.

2.7.2.3.6 SPECIFIC CONDUCTIVITY MEASUREMENTS

Specific conductivity reflects the ionic content of water. In situ measurements of specific conductivity were obtained in the May through September trips and are shown in Tables 2.7-65 through 2.7-70. Values in July were the lowest seen, ranging from 120 to 200 μmhos/cm, as seen in Table 2.7-68. Highest measurements were obtained in September, ranging from 230 to 260 μmhos/cm as indicated in Table 2.7-70. Samping stations are shown on Figure 6.1-4.

Specific conductivity measurements are seen to vary little among sampling stations. The only exceptions are again the stations located in Caney and Poplar Springs Creeks and Station 7 of Transects 2 and 3 which tend to have a higher specific conductivity than the other stations. This elevation of specific conductivity is not present in all samples and is not very great. In general, values obtained in the baseline survey were reasonably close to the 240 and 230 μmhos/cm readings recorded on February 16 and April 25, 1968, by TVA[32] at CRM 23.1 and which are listed in Table 2.7-61.

2.7.2.3.7 SOLIDS

Solids are usually defined as all matter that remains as residue after a water sample is dried at 221 degrees F and all water is evaporated. Volatile solid content is generally interpreted as being organic and fixed solid content as being inorganic. Settleable solids are those solids in suspension which will settle under quiescent conditions. Water quality measurements in Table 2.7-71 contain the physical and chemical analyses of various solid fractions of water samples taken from stations shown on Figure 6.1-2. Differences between sample stations appear insignificant, with the exception of the sample from Transect 5-Station 5 on September 24. Total solid content was 182 ppm for this sample, while other samples on that date ranged from 148 to 152 ppm.

Highest consistent total solid content was seen in the March samples (180 to 200 ppm); lowest values were seen in the May samples (136 to 148 ppm). In all samples, most of the total solid content was inorganic (fixed). Very little of the total solid (less than 0.1 ppm) was settleable in all cases. A significant fraction of settleable solids would be important because these solids could alter bottom sediments and cause smothering of benthic populations and fish spawning areas.

Suspended solids were much higher in the March samples than in the samples taken on other collection trips. Values in March ranged from 38 to 42 ppm in contrast to the lowest values, 4 to 12 ppm, obtained in June. Suspended solids in other months were more comparable to those in June than to those in March. In all samples, except those from June, fixed suspended solids were greater than volatile solids.

2.7.2.3.8 TURBIDITY AND COLOR

Turbidity pertains to suspended matter in water that interfaces with light transmission through water and in turn tends to restrict visual perception of depth. True color is due to various natural organic extracts. Turbidity and color measurements for the three sampling stations shown in Figure 6.1-2 are listed in Table 2.7-71.

Turbidity levels, although similar among the three sampling stations for all dates, showed much higher values in March than in the other dates. This pattern reflects the increased suspended solid content during the March trip, listed in Table 2.7-71. The turbidity values of 70 to 80 Jackson Turbidity Units (JTU) for March exceed the FWPCA Criteria[37] recommended maximum value of 50 JTU for a warm water stream receiving discharge. True color values were similar among the different sampling stations but were much higher in March than in the other months, probably as a result of organic materials extracted from runoff.

2.7.2.3.9 LIGHT PENETRATION

Light is necessary for photosynthetic organisms. The compensation level is that depth at which photosynthesis just balances respiration and is that depth at which light intensity is one percent of full sunlight.[38]

Light penetration readings were made at all field sampling stations shown on Figure 6.1-4. In Tables 2.7-65 through 2.7-69, light penetration is expressed as foot-candles and percent transmittance and an indication is given of the water depth at which one percent light transmittance is reached. In September, as shown in Table 2.7-70, a Secchi disc was used to obtain approximate values for the compensation point due to malfunction of the submarine photometer. On a later field trip, light penetration readings will be taken with both the Secchi disc and the photometer so that a comparison of Secchi disc and photometer readings can be made. The September data should then be able to be compared with other trips on which the photometer was used.

The shallowest depth of one percent light transmittance occurred on the March trip. This depth was usually no more than one foot below the water surface and never exceeded one meter at any of the stations, as shown in Table 2.7-65. Readings for the May, June and July trips, Tables 2.7-66 through 2.7-68, were quite similar, the compensation level most commonly being at depths of 3 to 4 meters. In August, these depths were consistently at 4 to 5 meters, Table 2.7-69. Secchi disc readings in September mostly fell in the range of 3.5 to 4.5 feet, as seen in Table 2.7-70. Within each trip, values were reasonably consistent among sampling stations, except for occasional decreases in the depth of one percent transmittance noted at sampling stations in Caney and Poplar Springs Creeks and their mouths.

Lack of light penetration during turbid periods may act to limit the extended existence of photosynthetic plants, such as macrophytes, in the study area.

2.7.2.3.10 pH, ALKALINITY AND HARDNESS

pH is a measure of the hydrogen ion concentration and in turn a measure of the degree of acidity or alkalinity of a solution. Alkalinity is a measure of the capacity of water to neutralize acids. Hardness of water is usually due to natural accumulation of calcium and magnesium salts. Soft water increases the sensitivity of fish and fish food organisms to toxic metals, while in hard water, toxic metals may be less dangerous.(39)

Stations for which pH was measured are shown on Figure 6.1-4 and the results are reported in Tables 2.7-65 through 2.7-70. Total alkalinity and hardness were sampled at the three stations shown on Figure 6.1-2 and the results are listed in Table 2.7-71.

Readings of pH at three depths at all stations sampled during March, June, August and September ranged from 7.7 to 8.3. This range falls within the acceptable range of 6.5 to 8.5 set by the Tennessee Water Quality Criteria(40) for fish and aquatic life. June and July values ranged from 8.5 to 8.7 and 8.1 to 8.55, respectively, and are near or out of the acceptable range. In order to cross-check the accuracy of equipment used to take water quality measurements in the field, additional water samples are collected on each field trip and water quality measurements are made with calibrated backup equipment. In June, the pH of these cross-check samples all read 7.95. In July pH readings on the water samples ranged from 7.8 to 8.0. Water samples used were collected from three of the sampling stations in June and five in July. It seems that the field measurements of pH reported for June and July were high due to field equipment malfunction and the actual pH values for those trips fall within the range of pH readings from the other collection dates.

Alkalinity at the three sampling stations was lowest in March, all three readings being 76 ppm ($CaCO_3$), and highest in September, with values ranging from 90 to 116 ppm ($CaCO_3$). There seem to be no significant differences between stations. Hardness followed the same pattern. March values of 82 to 96 ppm ($CaCO_3$) were lowest and September values of 136 to 138 ppm ($CaCO_3$) were highest. As shown in Table 2.7-61, TVA[32] reported alkalinity values ranging from 90 to 111 ppm ($CaCO_3$) and hardness values of 100 to 128 ppm ($CaCO_3$) from June 23, 1967 to April 25, 1968 at CRM 23.1. Water hardness values of 75 to 150 ppm are considered "moderately hard" and are characteristic for Tennessee.[41]

2.7.2.3.11 DISSOLVED OXYGEN

Oxygen is important because most living organisms depend on some form of oxygen to maintain biological processes which produce energy for growth and reproduction.[41] Most criteria dealing with dissolved oxygen in freshwater concern fish. Since fish are dependent upon other aquatic organisms for food and would probably not be in an area where food supply is inadequate, it appears reasonable to assume that fish requirements would also meet the requirements of the rest of the community.[37]

Dissolved oxygen (DO) measurements were done in profile at the stations indicated in Figure 6.1-4 and the results are reported in Tables 2.7-65 through 2.7-70. Data show a distinct pattern from March through September. Highest values were recorded in March, Table 2.7-65, with DO readings ranging from 11.3 ppm (101.8% saturation) to 10.2 ppm (91.9% saturation). DO measurements decreased steadily in the May, June, July and August trips. August DO values, the lowest recorded in the sampling period, ranged from 5.5 ppm (62.5% saturation) to 6.4 ppm (73.6% saturation) at stations not close to Caney and Poplar Springs Creeks. Stations in these creeks and their mouths showed higher DO values in August than did the other stations. This elevation of DO values in the creeks also showed up on some of the other sampling dates. DO values for September were greater than those for August, ranging from 6.6 ppm (71.7% saturation) to 7.3 ppm (82.0% saturation) for stations not closely associated with the creeks. Throughout the water column there was no distinct DO stratification. As shown in Table 2.7-61, TVA[32] reported DO values for CRM 23.1 which ranged from 5.9 ppm on September 26, 1967 to 11.7 ppm on February 16, 1968. Tennessee Water Quality Criteria[40] for fish and aquatic life states that 5 ppm DO in water is the minimum acceptable value; FWPCA Criteria[37] for fresh water organisms recommends DO be above 5 ppm.

2.7.2.3.12 BIOCHEMICAL OXYGEN DEMAND, CHEMICAL OXYGEN DEMAND AND TOTAL ORGANIC CARBON

Biochemical oxygen demand (BOD) is usually defined as the amount of oxygen required by bacteria while decomposing organic matter under aerobic conditions. The BOD test has particular application in evaluating the pollutional strength of domestic and industrial wastes in terms of the oxygen that they utilize when discharged into natural waters in which aerobic conditions exist. By means of this test, it is possible to determine the degree of pollution present in streams at a given time.[41]

Chemical oxygen demand (COD) is a reasonably close approximation of the total chemically-oxidizable carbonaceous content of a sample. The COD test is also widely used as a measure of domestic and industrial pollution. During COD determination, all organic matter is converted to carbon dioxide and water regardless of whether or not the organic matter is biologically assimilable. Thus, COD values may be significantly greater than BOD values when biologically resistant organic matter is present.[40] Total organic carbon (TOC) is measured in COD determinations. Water samples for BOD, COD and TOC were collected in March, May, June, July, August and September at the three sampling stations shown on Figure 6.1-2 and the results of analyses are presented in Table 2.7-71. Baseline survey data to date show mean BOD values of 2.2, 1.7 and 2.0 ppm for Transect 1-Station 5, Transect 4-Station 3 and Transect 5-Station 5, respectively. BOD values of 0 to 2 ppm are associated with water suitable for human consumption; whereas, values of 100 to 500 ppm are associated with normal raw sewage.[42] TVA[32] reported BOD values for CRM 23.1 which ranged from 0.0 to 1.6 ppm for June 23, 1967 to April 25, 1968, as shown in Table 2.7-61. Data from the baseline survey range from less than 1.0 to 6.0 ppm.

Mean COD values from samples collected to date are 8.2 ppm at Transect 1-Station 5, 7.95 ppm at Transect 4-Station 3 and 5.5 ppm at Transect 5-Station 5. Values ranged from 2.4 to 16 ppm. Mean TOC values for Transect 1-Station 5, Transect 4-Station 3 and Transect 5-Station 5 were 5.0, 5.4 and 3.7 ppm, respectively, with a range of 2 to 10 ppm.

2.7.2.3.13 NUTRIENTS

Nutrients are necessary for the growth of any living organisms. Nitrogen and phosphorus are the most obviously important elements for the growth of aquatic plants. Other nutrients, some of which are sometimes referred to as "micronutrients", are also important for aquatic organisms. Some nutrients identified[43] as being necessary for aquatic organisms include: sodium and potassium; calcium for vertebrates and for mollusk shell formation; magnesium as a necessary component of chlorophyll, and silicate as a structural component for diatoms. Nutrients in excessive amounts can contribute to the eutrophication of an aquatic system. Nitrogen and phosphorus are generally accepted as the fertilizing elements most responsible for nuisance blooms of aquatic plants. However, the concentration of these two elements that is necessary to cause blooms is not established.

Sampling for nitrogen, phosphorus, sodium and potassium was done in March, May, June, July and August at the three stations shown on Figure 6.1-2, while sampling for calcium, magnesium and silicate was done in March and September at the one location shown on Figure 6.1-9. Results of the analyses for nitrogen, phosphorus, sodium and potassium are presented in Table 2.7-71, while those for calcium, magnesium and silicate are shown with the water quality data in Table 2.7-72. Values for the various forms of nitrogen (NO_2, NO_3 and NH_3) are expressed as nitrogen. In a similar manner, the total and orthophosphate values are expressed as phosphorus.

As is shown in Table 2.7-71, nitrite (NO_2-N) was considerably greater in March than in the other months. Nitrate (NO_3-N) values were similar in March, May, June and September, but considerably less in July and August. Ammonia (NH_3-N) values were greatest in March (0.9-1.0 ppm) and least in June (0.04 to 0.09 ppm). Differences among sampling stations appear insignificant.

Elevated nitrite and ammonia values during the March trip are indicative of enrichment during this trip possibly as a result of agricultural runoff. Nitrogen measurements by TVA[32], shown in Table 2.7-61, taken at CRM 23.1 from June 23, 1967 through April 25, 1968, ranged from 0.01 to 0.03 ppm (NO_2-N), 0.23 to 0.57 ppm (NO_3-N) and 0.00 to 0.17 ppm (NH_3-N). These values are in general accordance with those in Table 2.7-71. Specific criteria for nitrite and nitrate maximum values for aquatic life have not been designated.

Total phosphate (PO_4) and orthophosphate values (as phosphorus, PO_4-P) were much greater on the March trip than on any other trip, as shown in Table 2.7-71. TVA[32] values shown in Table 2.7-61 for total PO_4 from CRM 23.1 for June 23, 1967 through April 25, 1968, ranged from 0.07 to 0.25 ppm. As PO_4-P this range would be 0.02 to 0.08 ppm. FWPCA[37] proposed maximum limit for freshwater aquatic life is 0.1 ppm (PO_4-P). Values for all sampling dates except March were well below this level. March values were at this level.

Values for sodium and potassium, listed in Table 2.7-71 and for silicate, calcium and magnesium, listed in Table 2.7-72, were not excessive. The 7.7 ppm of silicate was probably due to high flow and turbid conditions that prevailed during the March trip. TVA[32] values for CRM 23.1 for June 23, 1967 through April 25, 1968, shown in Table 2.7-61 were: Na (1.70 to 3.00 ppm); K (1.00 to 4.00 ppm); SiO_2 (1.1 to 4.6 ppm); Ca (26.0 to 34.0 ppm); and Mg (9.0 to 14.4 ppm). Thus the TVA values for 1967 and 1968 were generally similar to those values obtained in samples collected to date.

2.7.2.3.14 HEAVY METALS

Common usage of the term "heavy metal," from an ecological viewpoint, has meant a stable metal that is persistent and accumulative with time and toxic if present in sufficient quantity. Heavy metals that have been sampled during the aquatic baseline survey are molybdenum, selenium, tin, aluminum, manganese, zinc, copper, mercury, silver, arsenic, cadmium, chromium, lead, nickel, cobalt and iron. Sampling was done in March and September at the location shown in Figure 6.1-9, and the values obtained are shown in Table 2.7-72. Most values are below the limits of resolution of the analysis. Those metals which were present in measurable amounts were present in lesser quantities in September than in March.

2.7.2.3.15 ORGANIC COMPOUNDS

Sampling for the organic compounds cyanide, detergents, oil and grease, and phthalate esters was done in March and September at the one location shown on Figure 6.1-9. Values obtained for these materials are listed in Table 2.7-72. Cyanide and phthalate esters were below detectable levels. Detergents increased from less than 0.01 ppm in March to 0.1 ppm in September. Oil and grease decreased from 2.75 ppm in March to 1.8 ppm in September.

2.7.2.3.16 PESTICIDES

Sampling for pesticide content in the water was done in March and September at the one location shown on Figure 6.1-9. Values obtained are shown in Table 2.7-72. All compounds were below the limits of the analyses in March. In September, all were below detectable amounts except the herbicide 2-4-D. In one of the two samples collected in September, 2-4-D was present in a concentration of 0.06 ppm. This high value may be the result of a small contaminant in this sample.(44)

2.7.2.3.17 OTHER WATER ANALYSES

Chloride (Cl^-) is one of the major anions in water, sewage effluents and industrial wastes. Chlorine demand of water is the difference between the amount of chlorine added during chlorination and the amount of chlorine present. Chlorine residual is the free and combined available chlorine in the water. Sulfate ($SO_4^=$) occurs in water as leachings from various common minerals and is associated with acid mine drainage. Nitrogen gas has recently gained prominence in relation to gas bubble disease. Gas bubble disease has been related to supersaturated waters resulting from algal blooms, heated effluents of steam plants and dam spillways.(45) Fluorides, while they can occur naturally, are usually associated with water treatment.

Sampling for chloride, sulfate and chlorine residual was performed in March, May, June, July, August and September at the three locations shown in Figure 6.1-2 and the values obtained are listed in Table 2.7-71. Sampling for chlorine demand and nitrogen gas was done at the one sampling location shown on Figure 6.1-9 and analyses results were presented in Table 2.7-72. Sampling for nitrogen gas was done in March and September and for chlorine demand in May and September. Fluoride was sampled in March and September at the location shown on Figure 6.1-9. Chloride and sulfate levels, as shown in Table 2.7-71, did not differ appreciably between the three sampling stations. Sulfate levels were highest in March, whereas chloride levels were fairly uniform. Determination of chloride and sulfate levels for 1971 and 1972 were made by ORNL[33] and the results are shown in Tables 2.7-62 and 2.7-63. Chloride levels ranged from 1.0 to 5.5 ppm and sulfate levels ranged from 8.5 to 22.5 ppm. These values are quite comparable to those obtained in the baseline survey, and both sets of data meet the FWPCA[37] water quality criteria for public water supplies.

Total chlorine residual levels at all stations and sampling dates were less than 0.05 ppm. Data in Table 2.7-71 indicate that chlorine demand in both March and September were almost negligible.

Specific criteria for acceptable nitrogen gas values are not available. Nitrogen gas levels during the March and September field trips were 16.9 ppm and 14.9 ppm, respectively.

Fluoride levels, as shown in Table 2.7-72, were less than 0.1 ppm in March and 0.18 ppm in September. These values are well below the FWPCA[37] recommended limits of 0.8 to 1.7 ppm, depending on annual maximum daily air temperature.

2.7.2.3.18 SEDIMENT (PARTICLE SIZE AND TOTAL VOLATILE CONTENT)

Character of bottom substrate is important to many aquatic organisms. This is especially true of such bottom dwelling organisms as the benthic macroinvertebrates. Benthic macroinvertebrates are known to be very selective in bottom preference both in terms of particle size and organic content.[46]

Approximation of the organic content of sediment from the various stations was done by determination of the volatile solid content. Sediments were categorized on the basis of particle diameter according to the scale in

Table 2.7-73. Results from the samples collected in the March, May, July and September trips are shown in Tables 2.7-74 through 2.7-77. Samples were collected by Ponar dredge at locations shown on Figure 6.1-4. Particle size composition was in terms of weight. Results show the bottom to be varied throughout the sampling area. Analysis is complicated by the fact that at some stations, more than one sediment type was encountered. Highest values for volatile solid content were seen at Transect 5-Station 5 in May and July (15.4 and 11.0% respectively), Transect 1-Station 3 in March, May and September (9.1 to 11.4%) and Transect 2-Station 3 in March (8.5%). Dominant particle sizes in these samples were variable, in general being in the medium sand to gravel range. In most cases, samples with the smallest volatile solid content (less than 1%) were those samples in the gravel to boulder size range. It is difficult to characterize each station in regard to sediment type. One fairly constant feature seen is that the samples showing a dominance of finer particle sizes are usually from Station 3 of the various transects and Station 7 of Transects 2 and 3, located in the mouths of Caney and Poplar Springs Creeks, respectively. Station 3 of each transect is located on the right side (looking downstream) of the river and along the inner bend of the river. Sediment in a clean stream generally has an organic content of about one to four percent.[42] Stations which quite consistently show volatile solid contents markedly above this range, such as Transect 1-Station 3 and Transect 5-Station 5, appear to represent organically enhanced areas.

2.7.2.3.19 SEDIMENT (PHOSPHATE AND HEAVY METAL CONTENT)

Whereas the concentration of phosphate and heavy metal substances may be minute in fresh water, such substances may accumulate and concentrate in the sediments beneath these waters.[47]

In the sediment analysis presented in Table 2.7-78, total phosphate and some selected heavy metals in sediment samples collected from all the stations shown on Figure 6.1-4 in March are listed. At this point, these data are baseline in nature and will be used for comparison with data collected after the plant becomes operational. However, data from the Site confirms the statements made in the first paragraph of this section. Levels of total phosphate, aluminum, manganese, zinc, copper, chromium and total iron are higher in sediment samples than in overlying river water. The concentration of the heavy metals in Table 2.7-78 not discussed here were below the detectable limits used in the analysis of the sediment samples.

2.7.2.4 ECOLOGICAL PARAMETERS

Biological aquatic communities and populations in the Clinch River at the Site are described in the following sections. Locations of the sampling stations shown in Figures 6.1-2 to Figure 6.1-9 and the sampling and analysis procedures shown in Tables 6.1-1 to 6.1-3 are described in Section 6.1. Characterization of the Clinch River aquatic flora and fauna between river miles 15 and 18 is based on the results of the baseline sampling from March through October, 1974 and on information obtained from the literature.

2.7.2.4.1 BACTERIA

Fecal and total coliform bacterial counts[32] for the period covering June 1967 to April 1968 were recorded at CRM 79.8 and 23.1 and are presented in Table 2.7-61.

Results of bacterial sampling on March 26, May 29, June 27, July 22, August 26 and September 24, 1974, at the three sampling locations shown in Figure 6.1-2 are indicated in Table 2.7-70. Although there are some differences in bacterial counts among stations, these differences were less significant than the differences between sample times. Standard plate and total coliform counts were elevated on March 26, indicating an increase in total bacteria at that time. Elevated fecal coliform and fecal streptococcal counts on this same date indicate a substantial increase in bacteria of enteric origin. Increase of enteric bacteria indicates an increase in contamination by fecal waste of warm blooded animals.[48] Bacterial counts recorded by TVA[32] in 1967-68, reflect more closely the counts obtained by the baseline survey on May 29 through September 24 than on March 26. Only the 3,400 MPN/100 ml of total coliform for October 18, 1967, as recorded by TVA, exceeds the counts obtained by the baseline survey. Total coliform, fecal coliform and fecal streptococcus counts on July 22 are somewhat elevated, particularly at Transect 4-Station 3. However, these elevated values were not as great as values observed on March 26.

Proportionally high fecal streptococcus counts in relation to fecal coliform counts are associated with fecal contamination by farm animals,[48] as noted in Section 6.1. Therefore, values below one for the fecal coliform/fecal streptococcus ratio indicate that a significant portion of the wastes received by the river are of livestock origin. Values for this ratio on March 26 are 1.5, 0.8 and 1.3 and on July 22 are 0.2, 0.5 and 1.1. The May 29 samples show ratios of 13.0, 13.0 and 6.6. On other dates, counts for fecal coliform and fecal streptococcus are below or near the limits of the analysis, so the ratio is not applicable. Bacterial counts for March 26 therefore point to enrichment by agricultural run-off. This conclusion is substantiated in part by the results of chemical and physical water measurements mentioned in Section 2.7.2.3, which indicate that this was a period of high run-off and increased sediment load. A similar situation may exist on July 22. Though the bacterial counts are influenced by livestock wastes, only Transect 4-Station 3 shows more than a modest elevation in bacterial counts.

Total and fecal coliform counts recorded by TVA[32] and by the baseline survey to date are considerably below the maximum allowable limit of 5,000/100 ml for any one water sample as required by Tennessee Water Quality Criteria[40] for fish and aquatic life.

2.7.2.4.2 PHYTOPLANKTON

A short but intensive survey of phytoplankton and protozoa was conducted by ORNL during the summer of 1956.[49] Areas sampled included Watts Bar Lake below the access of water from the Oak Ridge area, the Clinch River, its embayments and other lakes and waters in the East Tennessee area. In 1956, the Clinch River waters, especially from Gallaher Bridge (CRM 14.0) down to Watts Bar Dam were lentic and warm, an extremely favorable environment for producing large phytoplankton and zooplankton communities. Lackey in 1956[49] characterized the plankton community from Norris Dam to the mouth of White Oak Creek as being "almost barren of plankton". He attributed this lack of plankton to the discharge of cold, plankton deficient water from Norris Dam. Since this 1956 study, the Clinch River system has been altered by the construction of another dam, Melton Hill Dam, in 1963 at CRM 23.

Of the 425 species identified during the 1956 study, 279 were phytoplankton and 146 were protozoa. Results of phytoplankton samples obtained from the Clinch River and adjacent waters in 1956 are shown in Tables 2.7-80 and 2.7-81. Chlorophyta (green-algae) appear to be the dominant group based on number of genera and species, followed by Chrysophyta (yellow-green algae, golden algae and diatoms). Blue-green algae, dinoflagellates and euglenoids were also found, but to a lesser extent.

Although the results of this survey add to the information about the Clinch River phytoplankton community, the results do not directly apply to the present baseline survey. Comparison is difficult because ORNL studied a large sampling area with many diverse habitats, including CRM 14.0 at Gallaher Bridge down to Watts Bar Dam. Sampling area of the present aquatic monitoring program only encompasses a region between CRM 15.0 and 18.0.

132 phytoplankton species were collected during the aquatic monitoring program at the three sampling stations, as shown in Figure 6.1-2, from March 26 to September 24, 1974. These species are listed in Table 2.7-82. March samples consisted of 89 to 98 percent of the division Chrysophyta (mostly diatoms) with the remaining percent being Pyrrophyta (mostly dinoflagellates), Table 2.7-83. From May to September, the divisions Chrysophyta and Pyrrophyta were still present; however, three additional divisions also appeared during this period. These three additional divisions were Cyanophyta (blue-green algae), Euglenophyta (euglenoids) and Chlorophyta (green algae). Table 2.7-84 indicates the four most abundant species collected during the March through September sampling period.

Total number of organisms per liter as shown in Tables 2.7-85 through 2.7-90 do not appear significantly different between stations for a particular sampling time. Total numbers of organisms per liter at each station from March through September, 1974, ranged from 311,108 to 2,940,145. Data in Table 2.7-85 indicates that the density of phytoplankton species in March was lower than at any other sampling time. Due to the high silt load of the river in March, extra replicate phytoplankton samples were analyzed to adequately determine the species abundance. The low density of the March samples was not a result of inadequate sampling but a real reduction in the river population at this time. Factors causing this small population were probably the heavy run-off and high silt concentration combined with the reduced physiological activity caused by winter temperatures. There has been an increase with a peak in July of the mean total number of organisms per liter from March through the summer months. During August and September the abundance of the phytoplankton community decreased slightly.

Species diversity indices for each sample and for each station from March to September are indicated in Tables 2.7-85 through 2.7-90. Diversity indices were computed by including the number of cells in the filamentous (mostly blue-greens) forms and by excluding these counts. Computed with and without the filamentous forms, the diversity indices ranged from 1.28 to 2.79 and 0.84 to 2.93, respectively. Including or excluding these forms does not significantly alter the range of diversity values observed. Diversity indices among stations for each sampling time remained relatively constant. Although the diversity indices for the March sampling are slightly lower than those of other field trips, there appears to be no significant diversity differences between field trips.

Phytoplankton species succession and pattern of abundance for the March through September sampling period are indicated in Tables 2.7-83 and 2.7-84. Percent composition of major phyla in samples, as shown in Table 2.7-83, indicates that the division Chrysophyta (mostly diatoms) was abundant in samples from March and May, decreased during June and July and increased during August and September. Blue-green algae (Cyanophyta) composed a small portion of the phytoplankton community in May, but during June and July, they became more numerous and composed the greatest percentage of the samples. In August and September, the occurrence of blue-green algae decreased. Green algae (Chlorophyta) composed a small percentage of samples from May to July, but increased significantly in August and September. Both divisions of Euglenophyta (euglenoids) and Pyrrophyta (mostly dinoflagellates) have occurred in most samples, but by an extremely low frequency.

The successional pattern observed from March through September, 1974, follows the pattern of phytoplankton succession which has been observed in the Tennessee area during the last seven years.[50] In summer the diatoms decrease in both number of species and percentage of species. Blue-green algae may increase during the summer but this increase will depend upon rain and river water levels. A summer increase in the number and percentage of green algae is also common. In early to mid-autumn blue-green and green algae decrease and the diatoms become the dominant phytoplankton group. Though the real numbers of diatoms decrease in the winter they still compose the greatest percentage of the population. Blue-greens are usually absent in winter but some green algae could be present.

Table 2.7-84 indicates that the four most abundant species from each field collecting trip from March through September, reflect the observed successional patterns. Diatoms were the four most dominant species in May but by midsummer they had been replaced in importance by species of blue-green algae. Difference in dominant species was not observed between sampling transects within a given sampling time and the dominant species listed in Table 2.7-84, for the most part, reflect the dominant species at each transect within that time.

Chlorophyll measurements of phytoplankton samples collected from June to September are shown in Tables 2.7-91 through 2.7-94. As would be expected, concentrations of chlorophyll a for the majority of samples exceeded those of chlorophylls b and c. Mean concentration of chlorophyll a for the month of June was 3.50 mg/m^3. During July, August and September, the mean concentrations of chlorophyll a were 2.83, 4.60 and 5.03 mg/m^3, respectively. Chlorophyll a concentrations from June to September ranged from 2.20 to 6.00 mg/m^3 and had a mean concentration of 3.77 mg/m^3. These values are similar to TVA values of approximately 3 mg/m^3 obtained in June to September, from a 1967 study at Norris Reservoir, Tennessee.(51)

Pheophytin a ratios are computed to determine the proportion of the chlorophyll a which can be accounted for by the physiologically inactive chlorophyll a degradation product, pheophytin a. Pheophytin a content ratios, based on the before and after acidification optical density readings at a wavelength of 663, are presented in Tables 2.7-91 through 2.7-94. The ratio values ranged from 1.0 to 1.6 with a mean value of 1.3 for the June through September sampling period. According to EPA(46) a ratio of 1.0 indicates the presence of only pheophytin a; whereas, a ratio of 1.7 indicates that samples are free of pheophytin a. Since a mean ratio of 1.3 is almost midway between 1.0 and 1.7, the phytoplankton population in the Clinch River from June through September can be considered as consisting of decaying and non-decaying individuals.

Uniformity among stations in terms of species diversity and total number of organisms per liter, shown in Tables 2.7-85 through 2.7-90 and the chlorophyll content, shown in Tables 2.7-91 through 2.7-94 during each of the sampling times indicates little overall difference in phytoplankton among stations. The considerable increase in total number of organisms and the slight increase in species diversity in May samples over the March samples is most likely a response to seasonal progressions with accompanying warmer temperatures.

2.7.2.4.3 ZOOPLANKTON

Thirty-six species of zooplankton were identified and counted by TVA from samples collected by oblique tows at CRM 17.1 on July 26, 1973.[52]

Zooplankton sampling stations are indicated in Figure 6.1-2; sampling and analysis methods are discussed in Section 6.1. A total of 56 zooplankton species, shown in Table 2.7-95, were identified. Sixteen of these species were arthropods and 40 were rotifers. In addition, several immature forms and other organisms were present which could not be identified to species level. Sampling data, in Tables 2.7-96 through 2.7-106, for the period of March through October, 1974, demonstrate that Rotifera, as is the case in most flowing systems, was the most abundant and diverse group. Members of the orders Cladocera and Copepoda compose nearly the entire arthropod population.

Summaries of the number of zooplankters per liter in both tow and pump samples from March through October are presented in Tables 2.7-107 and 2.7-108. Highest densities recorded from both towing and pumping samples were recorded in May. Lowest zooplankton densities were recorded during the March sampling trip. Density values declined in June but increased again in July and August, Tables 2.7-107 and 2.7-108. A comparison of transect values in Table 2.7-107 indicates that though the highest mean density occurred at Transect 4, there is not a significant difference among transects. The mean value at Transect 4 is large because of the high density recorded in May but the greatest variation in data occurs between sampling dates and not between transect values.

Zooplankton densities for pumped samples, in Table 2.7-108 show strong vertical stratification in the July 23 samples. Other sampling periods show a less pronounced stratification and do not show significant differences between transects. The reduced surface densities at Transect 1 in June and July are probably not caused by true transect differences but are the result of the variable distribution of zooplankton in a river environment. Mean values for pump samples in the water column suggest that some vertical stratification does occur. The surface samples average two to four times greater than the bottom samples.

Arthropods species show little vertical stratification, Table 2.7-109, but Rotifera species show an increase in numbers of individuals in the surface samples from July 23.

After the July 23 pumping samples demonstrated that the zooplankters could be stratified in the water column, surface tow samples were initiated to quantify the type and number of plankton in the surface layers. Results of a series of surface tows from September 26 are shown in Table 2.7-106. A comparison of this data, as shown in Table 2.7-109, with the vertical tow samples from September 26 indicates that the Arthropod distribution in the surface tows is not significantly different from the distribution in the vertical tows. Rotifera species, predominantly Keratella earlinae, Polyarthra vulgaris and Keratella cochlearis, are most abundant in the surface tows and cause the surface tow density to average twice the vertical tow density. Dominant organisms from the surface tows are shown in Table 2.7-110.

Tables 2.7-110, 2.7-111 and 2.7-112 show the most abundant organisms of each taxonomic group on each collection date. Dominant cladocerans, Bosmina longirostris and Diaphanosoma leuchtenbergianum, were abundant in all the samples collected. Bosmina density was greatest in the May and June samples. Daphnia retrocurva was present in all samples and was occasionally one of the most abundant species. Nauplius larvae and cyclopoid copepodids, both immature forms, are the most abundant groups of copepods and are present in all samples. Several different species of rotifers were abundant at various times during the sampling period. Only Polyarthra vulgaris, Conochilus unicornis and species of the genus Synechaeta seem to be consistently abundant. In general various species of rotifers were much more abundant than the cladocerans and copepods. Population peaks in May and August are primarily the result of increases in the number of rotifers.

Tables 2.7-113 and 2.7-114 show the diversity indices for each sample collected by vertical towing and pumping, with the mean diversity index calculated for each collection date and sampling station. Mean diversity indices are seen to be higher for samples collected in June, July, August and September than for those samples collected in March and May. There appear to be no significant differences among the mean indices for the three sampling locations.

The only study of zooplankton in the Site area which is comparable to samples collected from March through September, 1974, was conducted by TVA[52] at CRM 17.1 on July 26, 1973. Data collected at that time, as shown in Table 2.7-115 is comparable in terms of numbers and species to that collected in the spring and summer months of 1974.

Species of each of the major groups found during the baseline survey in the study area are typical of the hard-water zooplankton found throughout the TVA system. Data collected characterize the study area as being a typical, fairly clean flowing system. Species composition and abundance of zooplankton in the study area are primarily dependent on recruitment from Melton Hill Reservoir and on displacement from "dead" areas, such as creeks and backwaters, with little or no flow. This is due to the fact that flowing river systems are not conducive to the development of stable zooplankton communities. Zooplankton concentrations and composition in the study area need not replicate those in the reservoir because the zooplankton tend to stratify in the limnetic habitats of the reservoir and the dam discharge may not include all of the strata. In addition, the "dead" areas may make contributions to the zooplankton population in the rivers, especially during periods of low flow.[53]

Seasonal variation of the Clinch River zooplankton population should show a predictable pattern. Rotifers are observed to be dominant and quite abundant during early spring and summer, but are expected to reach their lowest diversity and abundance during the colder months. Cladocerans are abundant from March through October and copepods are expected to be present during most of the year, though not really abundant, except in the warmer months.[53] Data collected to date follow this pattern of seasonal zooplankton variation.

2.7.2.4.4 PERIPHYTON

Locations of periphyton sampling stations are indicated in Figure 6.1-3; sampling and analysis procedures are described in Section 6.1.

Sampling of the periphyton community involved the determination of periphyton species abundance, dominant species and community biomass during the four seasons of the baseline study. An attempt was made to maintain similar exposure periods for the plexiglass periphyton collection so that seasonal comparisons could be made. A sampling period of four weeks was initially selected for the March exposures but this was shortened to two weeks for the May samples. Subsequent exposure periods were approximately four weeks. Species enumeration per square centimeter from slides collected from March through October are shown in Tables 2.7-116 through 2.7-121. Though May 1 sampling data is for a two week period it is included in the comparison Table 2.7-122 because this data demonstrates the seasonal progression in species and abundance observed in the Clinch River. Because of the inability to obtain samples at Transect 1 in early May, two samples from this transect were collected on May 29 which are not comparable by transect or exposure time to any other samples. Data from these samples are presented in Table 2.7-118 but are not used in any of the subsequent comparisons or discussions.

Periphyton species that were collected from March 26 to October 23, 1974, are listed in Table 2.7-123. Five Phyla were represented in the 123 species and varieties collected from March through October. The greatest number of these, 65 species and 4 varieties belonged to the phylum Chrysophyta and were mostly diatoms. Other phyla were represented by 28 species of Chlorophyta (green algae), 24 species of Cyanophyta (blue-green algae) and one species each of Euglenophyta (euglenoids) and Pyrrophyta (dinoflagellates).

Total number of organisms per square centimeter at each sampling station and the mean of these values are presented in Table 2.7-122. Mean number of algal cells collected on plexiglass samples increased from a low of 112,004 in March to a high of 3,955,428 in October. Station and sample variation existed for each sampling period but this variation does not appear to be significant. All stations demonstrated the pattern of low densities in late winter to early spring and of high densities in late summer to early fall. Station variations encountered during the sampling period were caused by a high number of a few dominant species. Variations in March, June, August and October were caused respectively by high numbers of *Gomphonema olivaceum*, *Oscillatoria geminata*, *Eunotia exigua* and *Oscillatoria amphibia*. Sample variation, especially Sample B at Transect 4 in October, is greatly influenced by the number of Cyanophyta because the filamentous blue-green algae are reported as the number of cells in the filaments.

Species diversity indices were computed from the species and varieties of periphyton collected in samples from each station from March through October and are indicated in Tables 2.7-116 through 2.7-121. Diversity indices were calculated including, as well as excluding, the filamentous algae (mostly blue-greens) because of the variations that filamentous algae cause. During the sampling period, values ranged from 0.79 to 2.69 when including filamentous algae and from 0.37 to 2.81 when excluding filamentous algae. No apparent species diversity differences have been observed among sampling stations or among sampling trips.

Percent composition of samples by phyla based on species number and mean number of organisms per square centimeter by phyla from March through October are presented in Tables 2.7-124 and 2.7-125, respectively. Results in Table 2.7-124 demonstrate a pattern of succession and abundance in which the percentage of Chrysophyta (mostly diatoms) have decreased from March through October, while the Cyanophyta (blue-green algae) have increased. As shown in Table 2.7-125 the Chrysophyta reach a high density early in the spring and maintain their abundance through the summer while Cyanophyta increase in number during the summer and reach their peak in October. These results agree fairly well with the expected pattern of abundance and succession which has been observed in periphyton studies in the Tennessee area over the last seven years.[50] This expected pattern is a summer increase in blue-green algae and a decrease in percentage of diatom species. The proposed fall-winter pattern is a decrease in green algae and blue-green algae and a possible increase in diatoms. In winter, diatoms should dominate the periphyton community while blue-greens will be absent and green algae will be present in small amounts.

Table 2.7-126 indicates the four most abundant species determined by the total number of organisms per square centimeter on each field trip and on a cell basis, rather than on a filament basis for the blue-green algae. These dominants show the importance of diatom species in the March samples and gradual replacement of diatoms by the blue-green algae and green algae species in the later samples.

Results of chlorophyll a analysis and pheophytin a content ratio for samples collected from May through October are indicated in Tables 2.7-127 through 2.7-130. Organisms of the five divisions of periphyton (Chlorophyta, Chrysophyta, Cyanophyta, Euglenophyta and Pyrrophyta) collected during the sampling period, contain the green pigment, chlorophyll a. Chlorophyll b is only present in Euglenophyta and Chlorophyta, while chlorophyll c is present in Chrysophyta and Pyrrophyta.[54,55] Concentrations of chlorophyll a, as would be expected were higher than those of chlorophyll b and c for the entire sampling period. Mean values of chlorophyll a for samples taken in May, June, August and October were 39.30, 9.92, 8.41 and 55.76 mg/m^2, respectively. Chlorophyll b and c values also followed this pattern of decreasing concentrations from May to August and an increase in October. Mean number of organisms per square centimeter collected on each field trip, indicated in Table 2.7-122, correlate with the increasing concentrations of chlorophyll from August through October. While the mean total number of organisms from August to October increased twofold, the numbers of Cyanophyta (blue-greens) increased by a factor of four. Increases in number of individuals are not directly comparable to increase in chlorophyll content for several reasons. In addition to the increase of Chlorophyta (green algae) noted in Table 2.7-125, there were also several clumps of filamentous green algae collected in October samples which could not be broken apart, and therefore, are not enumerated. Likewise, Table 2.7-126 shows that in October, the green algae, Rhizoclonium fontanum, is one of the four most abundant species. This is a large species and an increase in its abundance would be responsible for a greater increase in chlorophyll a and b than a similar numerical increase in a smaller species.

Pheophytin a content ratios presented in Tables 2.7-127 through 2.7-130 are suggested by the EPA as a means of determining the amount of chlorophyll a degradation product which is present in the chlorophyll a fraction of a sample. This degradation product, pheophytin a, is not physiologically active and does not function in photosynthesis but has an absorption peak in the same region as chlorophyll a. Chlorophyll a measurements based on optical density readings at a wavelength of 663 report both chlorophyll a and pheophytin a contents; the pheophytin ratio is computed to determine the amount of physiologically active chlorophyll a actually in the sample. According to EPA[46], a ratio of 1.0 indicates the presence of only pheophytin a, whereas, a ratio of 1.7 indicates that the samples are free of pheophytin a. Communities with ratios of 1.7 are considered by the EPA to contain intact non-decaying individuals. Pheophytin a content ratios of samples collected from May to October were relatively constant and ranged from 1.17 to 1.80. EPA[56] has confirmed that values above 1.7 have been reported from several periphyton communities but these high values are difficult to interpret at the present time. The mean pheophytin a value from May, June, August and October samples, excluding values greater than 1.7, was 1.6. Mean of all the pheophytin a ratios, including values greater than 1.7, was 1.64. These relatively high values suggest that during the sampling period the periphyton community consisted predominantly of non-decaying photosynthetically active individuals.

Tables 2.7-127, 2.7-128 and 2.7-129 contain results of ash free dry weight and autotrophic index analyses of samples collected from May to August. The autotrophic index is a ratio expressing the relationship of biomass to chlorophyll a. This index may increase as the biomass of heterotrophic, non-chlorophyllous organisms increases as a result of the discharge of non-toxic organic wastes into surface waters.[57] Also, an autotrophic index increase could possibly show the effect of increased water temperatures. A mean autotrophic index value of 233 was obtained for samples taken during this period. EPA has suggested that values greater than 100 may indicate the presence of organic materials.[46] Factors such as leaf litter and high silt concentration from heavy run-off may have influenced the autotrophic indices. Ash-free dry weight measurements taken from May to August ranged from 736 to 4,625 mg/m^2.

Periphyton investigations including autotrophic index analyses, have been done in 1966, 1968 and 1970 by TVA on the Green River in Kentucky.[58] However, it is impractical to compare TVA autotrophic index values to those of the Clinch River baseline surveys since the formula and analysis procedures used to calculate these indices varies between the two studies.

2.7.2.4.5 BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates (benthos) were sampled by dredging and use of artificial substrates. Procedures used in sampling and analysis are discussed in Section 6.1 and listed in Tables 6.1-1 to 6.1-3; sampling locations are indicated in Figures 6.1-4 and 6.1-5.

Macroinvertebrates collected by dredging included the mollusks, annelids, flatworms and insects listed in Table 2.7-131. Insects (primarily Chironomidae) were the dominant group in terms of total number of species collected and comprised over 50 percent of those species listed in Table 2.7-131. Tables 2.7-132 through 2.7-137 indicate the type and number of organisms collected at each station from March, 1974 through September, 1974. Table 2.7-138 contains the relative abundance of each species collected during the March through September sampling period. Abundance of individuals from eight taxonomic groups during the early spring to early fall period are listed in Table 2.7-139. This table demonstrates the development and seasonal change in the Clinch River benthic community. Seasonal variation in populations is shown by the lower number of individuals in the March samples and the higher numbers collected in the summer samples. Though the Diptera, Annelida and Mollusca are present as dominants in all the samples, the Coelenterata was a dominant only in the May and August samples because of the rapid increases and declines of the Hydra population during the sampling period. Density of benthic organisms per square meter ranged from a low of 75 in March to a high of 467 in May when Hydra was most plentiful and to a high of 338 in September when Corbicula was most plentiful.

Three dominant species from dredged samples collected during each collecting trip are listed in Table 2.7-140. Corbicula was a dominant organism throughout the sampling period. High numbers of Hydra in the June 1 and August 26 to 28 samples made Hydra a dominant species for these samples. Annelid individuals were common throughout the summer and the tubifex worm, Limnodrilus, was a dominant species from June to September. Though Chironomidae were numerous in all samples only Polypedilum (scalaenum type) in March and Glyptotendipes in September were found in abundance great enough to make them a dominant species for these samples.

Dipteran individuals reached their maximum abundance in May, remained abundant through July and then declined in August and September. Annelida attained a population peak in May, then declined in July but attained another peak in September. Mollusks, predominantly the clam Corbicula, exhibited the two population peaks that were characteristic of the other dominant groups. Table 2.7-141, containing size frequencies, and Table 2.7-142, containing percent compositions of clam lengths taken from Tables 2.7-143 through 2.7-148, indicate that the early June and late summer increases in the clam populations represent the increase in small clams which were spawned in May and during the summer months.

Species diversity indices, shown in Table 2.7-149, point out the low diversity of benthic macroinvertebrates in the study area during the sampling period. These results agree with the TVA[59] findings that benthic populations were "sparse" between CRM 10 and 22. Diversity values at sampling stations ranged from 0.00 at stations where only

Corbicula was present to 1.90 at a station containing a number of annelids and dipterans in addition to Corbicula. Table 2.7-149 indicates that no significant benthic diversity differences occur among transects in the study area.

One factor which significantly affects the distribution of macroinvertebrates in the aquatic environment is substrate type.[46] Distribution of four taxonomic groups of benthic macroinvertebrates is related to sediment particle size composition in Table 2.7-150. For comparison purposes the sediment types in the Clinch River have been grouped into gravels (>5.6 to 1.7 mm), sands (1.7 to 0.25 mm) and fine sands (0.25 to 0.075 mm) based on the analyses of sediment samples as shown in Tables 2.7-73 through 2.7-77. Organisms from each sampling station have been grouped by the sediment size which was identified as composing the greatest percentage by weight of a sediment sample from that station. Annelid species, primarily Limnodrilus, were dominant in the fine sand sediments. Corbicula is widely distributed but is the dominant organism in the coarse to medium sand substrate type. Coelenterates, populations of Hydra, show a peak of abundance and dominance in the gravel substrate in June.

Macroinvertebrate biomass was expressed as composite blotted and ash-free dry weight and further subdivided as percent of biomass in terms of Corbicula alone and as "all other organisms". In all measurements, the Corbicula with the shell were used. Biomass recorded for dredge samples from each station during the March through October sampling period is shown in Tables 2.7-151 through 2.7-156. A comparison of transect results for each sampling date in Table 2.7-157 shows that biomass varied greatly at all transects but that transect differences were not significant. Mean biomass values for each sampling date ranged from 4,913 to 991 mg/m^2. This variation is mainly the result of the presence or absence of clams. When present, Corbicula averaged 90.8 percent of the ash-free dry weight of a sample. Samples with clams ranged from 11,400 to 2 mg/m^2 but samples without clams ranged from 92 to 0 mg/m^2.

Macroinvertebrate species collected on artificial substrate samples recovered from June through September are listed in Table 2.7-158. Forty-four species were identified from seven classes of invertebrates with dipteran species, predominantly Chironomid larvae, representing over 50 percent of the total species. The number of individuals of each species for each exposure period are indicated in Tables 2.7-159 through 2.7-162. Data on the abundance of the six major taxonomic groups are summarized in Table 2.7-163. Dipteran species were most abundant and a dominant organism on samplers collected in July. Dipteran numbers decreased in August and September samples but only _Hydra_ were more abundant than the dipterans. Annelida, mainly _Nais_, were the second most abundant individuals on July samplers but their numbers decreased significantly in August and then increased again in September. In July, the annelid _Stylaria_ was identified as quite common on one sampler at Transect 4 but was not collected again during the sampling period. Trichopteran species, predominantly _Psychomyiid Genus A_, increased to a maximum on the September samplers. Mollusks, the genus _Corbicula_, increased through the summer months and size frequency tables indicate that population increases were caused by summer spawnings. Coelenterate populations followed the pattern of rapid increase and dominance that were observed in the dredge samples.

Comparison of the most abundant species by transect is presented in Table 2.7-164. Hydra were present on all samplers during the summer and were the most abundant individuals on the samplers collected in August and September. _Nais_ was the most common annelid and was found in similar numbers at the three transects. _Dicrotendipes_ was the dominant chironomid species on artificial substrates and its density was very constant throughout the summer. _Glyptotendipes_ was a chironomid that was abundant on the samplers recovered in July but was not commonly found later in the summer. The Trichopteran _Psychomyiid Genus A_ first appeared as a dominant on the August samplers and its number had increased on the September samplers. _Corbicula_ also increased in abundance on samplers recovered later during the summer. Corbicula and Hydra were the only species which exhibited transect differences. Corbicula was found most consistently and in greatest numbers on the substrates at Transect 4. Hydra was least abundant at Transect 4 in each of the three sampling periods.

Though the populations on the artificial substrates do not represent the benthic population found by dredging, these substrates, because of their exposures, can be used to compare conditions and populations from different transects in the study area. Comparison of Tables 2.7-131 and 2.7-158 shows that 28 of the 44 species collected on substrates were also found in the dredge samples. Artificial substrates show that the greatest number of Corbicula and Psychomyiids occur in September because of an increase in the recruitment of these species over the summer and not because of dredge sample variations.

Biomass determinations for artificial substrates in the four sampling periods are presented in Tables 2.7-165 through 2.7-168. A comparison of these biomass results by transect and sampling data are shown in Table 2.7-169. Biomass values range from 874 to 152 mg/m^2 but the variation among transects does not appear significant. Mean biomass increased from 397.2 mg/m^2 in July to 723.2 mg/m^2 in September.

Species diversity indices for artificial substrates are given in Tables 2.7-160, 2.7-161 and 2.7-162, and these diversity values are compared by transect and sampling date in Table 2.7-170. Values were higher than those reported from dredge samples and they ranged from 1.9 to 0.36. The highest values were recorded from July samplers. Lowest diversity indices were recorded on samplers collected in August because of the large number of Hydra present on these samplers.

Immature stages of the dipteran family Chironomidae (chironomids, midges and bloodworms) are, as a group, one of the most sensitive biological indicators of water quality. Members of this family have wide ranging environmental requirements and habitat preferences, abundant standing crop and large species diversity, cosmopolitan distribution and distinctive morphological differences.[60] Chironomidae have been incorporated into an EPA[46] table which divides benthic macroinvertebrates into tolerant, facultative and intolerant members on the basis of tolerance to decomposable organic wastes. Tolerant organisms are described as those frequently associated with gross organic contamination and being capable of thriving under anaerobic conditions. Facultative organisms are those having a wide range of tolerance and are frequently associated with moderate levels of organic contamination. Intolerant organisms are those not found associated with even moderate levels of organic contamination and are generally intolerant of even moderate reductions of dissolved oxygen. Because tolerant species can be found in both clean and polluted water their presence or absence is of little value. Presence of intolerant organisms, even in small numbers, is positive evidence that only one condition, clean water, exists.[46]

Ten members of the family Chironomidae, listed by the EPA[46] as being intolerant to decomposable organic wastes, were collected in benthic dredge samples, see Tables 2.7-171 through 2.7-176. At least one of these indicator species was found at each transect during the sampling period. Eight species classified as intolerant were collected on the artificial substrates, Tables 2.7-171, 2.7-177, 2.7-178 and 2.7-179. This is strong evidence that the survey area, CRM 15 to 18, is not widely contaminated with decomposable organic waste.

Corbicula, in terms of biomass, is the dominant benthic macroinvertebrate in the study area as shown in Tables 2.7-151 through 2.7-156. Very little is known about the usage of this clam as a food item for other organisms; however, piles of empty shells along the shoreline are common and imply that it is being used for food by other animals. Fish food preference Tables 2.7-205 and 2.7-206 in Section 2.7.2.4.9 indicate that Corbicula may be a common food of carp and smallmouth buffalo.

The following information about Corbicula has been obtained from the study and literature review of Sinclair and Isom.[61] Corbicula, commonly referred to as the Asiatic clam, is an introduced mollusk in this country. It was first discovered in the Western Hemisphere in the Columbia River, Washington State in 1938.[61*] By 1963 it had spread over virtually the entire Tennessee River and lower Cumberland Basins. Taxonomy of this clam is complex and it appears that the Tennessee River Corbicula are of one species. Spawning time for this clam in Tennessee is July through November with the earlier larval stage being free-floating followed by a benthic stage. Corbicula in Tennessee feeds on phytoplankton and does not appear to be very substrate selective. From an economic viewpoint the clam is considered to be a liability. Larvae can be drawn into water intakes and cause fouling problems. TVA steam plants have experienced such problems and are attempting to remedy the fouling by chlorination. Although Corbicula has been reported[61**] to be used widely as a food item for humans in Japan, the possibility of commercial harvest for food has not been explored in this country. Fresh water drum fish have been reported as utilizing Corbicula. Studies on age and growth of Corbicula have not been made on Tennessee clams. Corbicula leana has been reported in Japan to attain a length of 10 mm the first year and 20 mm after two years of growth.[61+] Corbicula from Trotters Ferry, Tennessee measuring 43 mm were estimated to be in their fifth summer of growth.

Listed in Tables 2.7-143 through 2.7-148 and Tables 2.7-180 through 2.7-182 are the total lengths of identified Corbicula which were collected by dredging and on artificial substrates at the various stations from March through October, 1974. This data is expressed in graph form in Figures 2.7-9 through 2.7-17. Assuming that there is only a single species of Corbicula in the study area, these figures indicate that there are possibly three age classes of Corbicula in this area of the Clinch River. Using the information on age and length reported by Sinclair and Isom[61] and Bickel[62] the age classes of Corbicula in the study area are estimated to be one, two and three years old. Bickel[62] states that clams beginning their second winter in the Ohio River at Louisville, Kentucky had reached 16 to 20 mm. Those clams above 20 mm were assumed to be in their third summer of growth. Size frequency curves constructed from clams collected in dredge samples, Figures 2.7-9 through 2.7-14, show that the greatest number of clams are in their first summer of growth and large clams are a small percentage of the population. Bickel observed this same population structure in the Ohio River. He attributed this pattern to intense spawning in the summer and high winter mortalities in all classes because of increased suspended sediment loads in February and March. It can be assumed that the population in the Clinch River will also decline over the winter months and then spawnings in the spring and summer will increase the population to a fall maximum.

Clams collected on artificial substrates, shown in Tables 2.7-180, 2.7-181 and 2.7-182, indicate the recruitment to the Corbicula population which has occurred during the exposure period of the substrates. Table 2.7-183, containing size frequencies, and Table 2.7-184, containing percent composition of clams from artificial substrates, show that the age structures are similar on these substrates though the number of clams is increasing during the summer. This pattern indicates that Corbicula spawning occurred throughout the summer in this region of the Clinch River and was greatest in August and September.

Other mollusks which have been identified from the Clinch River in the approximate vicinity of the Site include the clams Anodonta corpulenta and Quadrula pustulosa. These species were collected in 1960 between CRM 4.7 and 14.5.[63] Five additional species were identified in 1968 during a survey of mollusks of the Oak Ridge area.[64] These species included the clams Pisidium casertanum, Pisidium punctifera and Fossaria parva and the operculate snails Pleurocera canaliculatum and Goniobasis clavaeformis. During the baseline survey one individual of the genus Dromus was recovered in July from Transect 1-Station 3. A few individuals of the gastropod genus Ferrissia were collected by dredging in September.

Benthic macroinvertebrates were identified and quantified in studies on the Clinch River related to the Kingston Steam Plant[36] at CRM 2.7 in 1968 and the Bullrun Steam Plant at CRM 47.5 in 1967-68.[34] Macroinvertebrate composition at these study sites, although not identical to that identified for CRM 15 to 18 by the baseline study, was generally similar. This would indicate that the benthic population at the baseline survey site is not unique in comparison to populations in other sections of the Clinch River.

2.7.2.4.6 MACROPHYTES

Sampling locations for macrophytes are indicated in Figure 6.1-6 and procedures employed are listed in Tables 6.1-1 to 6.1-3 and in Section 6.1. Distribution of macrophytic growth at the five sampling transects was sparse during the March, May and July field investigations. Origin of a few strands of Eurasian water milfoil that were collected during March and May is uncertain. These strands may have been rooted in the Site area or they may have drifted downstream from the Melton Hill Dam area. In March a cursory inspection of the midriver sand bar at Transect 4 during low river water levels revealed only a few seedlings which appeared to be of a terrestrial nature. Occasional growths of the bryophyte *Fontinalis* sp. on submerged branches and the leafy liverwort *Scapania* sp. were encountered during the May and July field trips.

The sparse growth of macrophytes in this area might be attributed to limited light penetration in the water, steep shorelines along much of the study area, occurrence of hard substrate and considerable fluctuations of river water level (see Section 2.7.2.3 on Physical and Chemical Parameters).

2.7.2.4.7 FISH POPULATIONS (JUVENILE AND ADULT)

Several studies have been conducted of fish populations in the Clinch River near the Site. Most recently, TVA surveyed fish populations in February, in April-May and in August of 1973 at three locations (CRM 15.7, 16.5 and 17.9) using electroshocking and gill nets at each location.[65] Of the 1,628 fish collected, 75 percent were obtained by electroshocking and 25 percent by gill netting. Forage fish, mostly gizzard and threadfin shad, accounted for 74.4 percent of the samples while rough and game fish accounted for 18.7 percent and 6.9 percent, respectively. A fish tagging study[66] was conducted from 1960 to 1961 at CRM 20.8 in the vicinity of White Oak Creek, before construction of Melton Hill Dam, to determine the migration of fish in this portion of Clinch-Tennessee River System. Fish were caught in hoop nets, identified by numbered tags and released at the point of capture. Of the 5,244 fish tagged, 226 (4.31%) were recovered. White bass and white crappie had the greatest recovery rate. Additional information, on the migration of smallmouth buffalo in White Oak Creek, Clinch River and Watts Bar Reservoir was obtained during the development of a radioactive tagging method of detecting fish movement.[67]

Six fish collections were made at the sampling stations indicated in Figure 6.1-7. Collection and analysis methods used are described in Section 6.1.

Collections were made from March 29 through September 26, 1974. Gill netting was used on all six sampling trips and electroshocking on all except the March trip. Hoop netting was attempted on September 23 but no fish were captured. Total duration of gill netting was 38 to 47 hours per station. Nets were set overnight on June 24, 25 and 26 (17 to 21 hours per station) and September 25 and 26 (15 to 17 hours per station). On all other dates, gill nets were set for one to three hours per station. Electroshocking was performed for 10 to 20 minutes at each sampling station during each sampling period as described in Section 6.1.

Species collected during the sampling period are listed in Table 2.7-185. A total of 30 species belonging to 10 families have been collected to date. Also shown are the total number of each species collected and the number of each species collected by each sampling method. Of the total of 611 fish collected, 386 have been collected by gill netting and 225 by electroshocking.

Species collected have been divided into the broad categories of "game", "forage" and "rough". Game fish include the centrarchids (rock bass, crappie, bluegill and other sunfish), percichthyids (white and striped bass), and the percids (sauger and yellow perch). The terms "rough" and "commercial" are often applied synononomously. Forage fish are those species which are preyed upon by predator species, including game fish.[68]

Table 2.7-186 indicates the relative abundance of the species collected in terms of number of fish collected and weight. Forage fish comprise 54.0 percent of the total number of fish collected and threadfin shad are by far the most dominant forage fish in the catch. Game fish make up 12.4 percent of the total. Bluegill are the most abundant game fish. Rough fish, of which skipjack herring are most numerous, make up 33.6 percent of the total. Rough fish are dominant in terms of weight, as they comprise 70.3 percent of the total weight. Forage fish and game fish make up 17.3 and 11.9 percent of the total, respectively.

Total number of each species collected by gill netting at each sampling station is shown in Table 2.7-187. Threadfin shad and skipjack herring are the most numerous species collected by gill netting. Table 2.7-188 gives the same comparison for fish captured by electroshocking. Gizzard shad and golden redhorse are most abundant species collected by electroshocking. Differences between species and size composition of gill nets and electroshocker catches may be due to gear selectivity or intrinsic factors such as species behavior, size class differences or both.

Table 2.7-189 indicates numbers of each species collected on each sampling date by gill netting. Threadfin shad have been among the most abundant species captured on each field trip. Skipjack herring were captured in relatively large numbers in March and May but have decreased in abundance in the summer months. Table 2.7-190 shows numbers of each species collected on each sampling date by electroshocking. In general, gizzard shad and golden redhorse are the most abundant species captured by electroshocking in June. In August and September, threadfin shad were most numerous.

Species diversity indices computed for fish collected from March 28 through September 26, 1974, by both gill netting and electroshocking are shown in Table 2.7-191. Diversity indices for electroshocking do appear to be greater in general than those for gill netting. Indices averaged 1.8 (range 1.2 - 2.1) for electroshocking and averaged 1.5 (range 0.73 - 1.95) for gill netting. These values exceeded the less-than-one value reported by Warren[69] for polluted water and indicate that the Clinch River in the vicinity of the Site is unpolluted.

Tables 2.7-192 and 2.7-193 show the total number of each of the seven most abundant species collected by gill netting and electroshocking from March 28 through September 26, 1974. Condition factor "K" has been calculated for each of the seven species per station and per field trip and the mean "K" factor is also computed for each species. This factor takes into account that the weight of a fish varies with the cube of its length and enables a comparison to be made of the physiological condition of fish within one species.[70] Mean "K" factors calculated at the end of the sampling program will indicate the "condition" of species in the vicinity of the CRBRP Site during the Baseline Survey Program.

Table 2.7-194 show the back calculated standard lengths of the designated seven most abundant species. Results to date indicate that the growth rates fall into the approximate range described for each species.[70]

An attempt was made to gather information pertaining to commercial and sport fishing in the area of the Site. No data were available on sport-fishing harvest from either Watts Bar Reservoir or Melton Hill Reservoir.[71] Commercial catches in 1972 within a 10-mile radius of the Site were negligible and amounted to about one percent of the total catch from Watts Bar Reservoir or around 1,000 pounds.[72]

Tables 2.7-195 and 2.7-196 present data from a recent TVA fish survey[65] conducted between CRM 15.7 and 17.9 on three different dates during the period of February 1 through August 10, 1973. Results to date of the present baseline survey are in general agreement with TVA findings in terms of fish species composition, abundance and proportion of game, rough and forage fish.

A fish investigation was conducted at the Bull Run Steam Plant on Melton Hill Reservoir from January 1967 to February 1968.[35] Also a fish tagging survey[66] was done in the Clinch River near White Oak Creek (CRM 20.8) on July 6 through September 21, 1960, and from April 12 through July 31, 1961. Both studies showed a similarity in species composition of collected fish to the present baseline survey results. In addition, the fish tagging survey showed that several species being collected during the baseline survey tend to migrate considerable distances in the Tennessee River System. These fishes include the sauger, skipjack herring and white bass. One sauger was captured 100 miles from the point of release.

2.7.2.4.8 FISH EGGS AND LARVAE

Fish eggs and larvae were sampled on a regular basis from March 28 through August 29, 1974, at the locations indicated in Figure 6.1-8. Sampling and analysis procedures are described in Section 6.1. This sampling period was considered critical since intermediate and warm water fishes are spring and summer spawners.[73]

Fish eggs and larvae collected by stationary netting during eleven sampling trips are shown in Tables 2.7-197, 2.7-198 and 2.7-199. Eggs were not identified as to species. Larvae of two fish, sauger and redhorse, were collected. In addition to stationary netting, pumping was also used as a sampling method for demersal eggs. One reason why only a single egg was collected by pumping may be the absence of spawning grounds in the sampling area.

Tables 2.7-197 and 2.7-198 show the number of fish eggs and larvae collected on each sampling date. Significant numbers of eggs were collected only on May 16 and June 2 and indicate the onset of spring spawning for the species represented by these eggs. This suggests a rather short but intense spawning period for these fish species. Samples taken on all other dates yielded very few if any eggs but indicate that fish species spawn in the vicinity of the Site from March through July. Of the 296 eggs collected, 93 percent were collected on May 16 and June 2. The single fish larva collected on March 28 was identified as a sauger larva, while all 13 larvae collected on June 25 and 26 were redhorse larvae.

Table 2.7-199 shows the number of fish eggs and larvae collected at each station during the sampling period. There seem to be no significant differences among the river sampling stations in the number of eggs collected. Of the 296 eggs collected, 280 were from the river and only 16 from Poplar Springs Creek and Caney Creek. This may be somewhat misleading, however, as the river stations were sampled eleven times and the creeks only four. Despite this fact, all 13 redhorse larvae were collected from the creeks, and only one larva, a sauger, was collected from the river.

Eggs collected by stationary netting near the bottom are probably semi-buoyant and drifting in the current. Eggs which are attached to objects on the river bottom or in nests are not likely to be collected by the sampling methods employed except by chance. If the eggs collected are of the floating type, they are probably not the eggs of any of the seven most abundant species described in Section 6.1, as the eggs of these species are not known to be buoyant, see Appendix to 2.7. Sauger eggs, which do become semibuoyant after hardening may be an exception. These seven species should have been spawning during the collection period. All will spawn in the shallow waters of large rivers, although the preferred bottom type varies somewhat with the species.[74]

Data collected in the March through August sampling period indicate that eggs capable of being collected by the sampling methods employed are abundant during a rather brief time in the spring. Fish larvae appear to be scarce at the sampling stations on the river for the entire sampling period. Redhorse larvae collected in Poplar Springs and Caney Creeks suggest that these areas are important sites of spawning, at least for that particular species. This is somewhat speculative, however, as samples from the creeks contained few eggs.

2.7.2.4.9 FISH FOOD PREFERENCE

An analysis of stomach contents reveals the importance of food species in the fish diet. Seasonal changes in species or size - composition of the plankton or benthic community may cause the fish to change their feeding habits.

Certain fish collected at the stations indicated in Figure 6.1-7 were used for food preference studies. Sampling and analysis procedures used are indicated in Section 6.1.

Fish food preference data were collected to determine feeding habits of the seven most abundant species described in Section 6.1 and to correlate their feeding habits with data collected on the organisms which appear to be preferred food items. Food items were identified as precisely as is practical and the numbers of each food type presented where applicable. Percent occurrence of each food item represents the percentage of individuals of each fish species whose stomachs contained that food item. From the percent occurrence together with the numbers and weights of food items found in the stomachs of each species an estimate can be made of the most desired and most heavily fed upon organisms. Percent fullness of the stomachs and weight of the stomach contents in relation to fish size also indicate that level of feeding intensity of the fish at the time of capture. Fish from which stomachs were obtained were collected between March 28 and September 26, 1974, by both gill netting and electroshocking.

Table 2.7-200 shows the results from the analyses of 12 sauger stomachs of which only two contained food items. Adult sauger feed primarily on small fish and to a lesser extent on invertebrates, while younger sauger feed on a mixture of micro- and macroinvertebrates dominated by mayflies, zooplankton and chironomids.[75] Due to the high percentage of empty stomachs, not enough data is available to characterize the diet of sauger in the area of the Site. Food items recovered from the stomachs, although few in number are similar to those reported by Hubbs and Lagler.[76]

Adult skipjack herring feed mostly on fish, while younger members of the species prefer insects.[70,77] Table 2.7-201 shows that eleven of the 34 skipjack herring stomachs analyzed contained food items which consisted primarily of fish and benthic macroinvertebrates. Terrestrial insect and macrophyte fragments were also present. Fish species identified in the stomach contents included threadfin shad, skipjack herring and a member of the genus *Notropis* (shiners). Benthic macroinvertebrates present were larvae, pupae and adults of aquatic insects, the most numerous of which were *Chaoborus* sp. and the mayfly, *Hexagenia bilineata*.

Food items recovered from the stomachs of white bass are shown in Table 2.7-202. Nine of the 16 stomachs examined contained food items consisting of fish, crustaceans, aquatic diptera and mayflies. Threadfin shad was the only fish species identified in the stomach contents and the cladoceran, Leptodora kindtii, was the single crustacean present. Benthic macroinvertebrates consisted of larvae and pupae of Chaoborus sp. and of Hexagenia bilineata. Adult white bass were reported as feeding mainly on fish and less frequently on mayflies, crustaceans and aquatic insects.[75] Young white bass feed on other fish, insect larvae and microcrustaceans.[75]

As shown in Table 2.7-203, all 29 gizzard shad stomachs contained food items consisting of zooplankters, benthic macroinvertebrates, phytoplankton and macrophyte fragments. The bottom sediment present is incidental material taken in while feeding.[77] Zooplankton found in the food material consisted of cladocerans, copepods and rotifers with the cladoceran, Leptodora kindtii being the most common species. Various chironomids and Hydroptila sp., a caddisfly, comprise the benthic macroinvertebrates present. Adult gizzard shad are considered to be herbaceous, feeding on algae, phytoplankton and microscopic plants; younger fish feed on zooplankton.[75] Data reported to and summarized by Carlander[70] indicated that small gizzard shad feed on rotifers, protozoa and entomostraca in the early weeks of their life, but they switch to zooplankton and phytoplankton for the remaining part of their life. Since the invertebrates found in these fish stomachs are members of the drift community, they may have been ingested while the gizzard shad were feeding on plant material in the plankton or on the bottom.

Table 2.7-204 shows food items collected from stomachs of threadfin shad. Thirty-seven stomachs were analyzed and 22 of these contained food items. The food items consisted of a variety of zooplankters, a few benthic macroinvertebrates, phytoplankton and miscellaneous material such as bacteria, detritus and sediment. The most abundant organisms were the cladocerans, Bosmina longirostris and Leptodora kindtii, and Keratella sp., a rotifer. Threadfin shad feed mainly on zooplankton.[70]

Nineteen out of 22 carp stomachs contained food items listed in Table 2.7-205. A wide variety of food items were present, including zooplankton, benthic macroinvertebrates, mollusks, annelids, terrestrial insects, plant material, detritus and bottom materials. Benthic macroinvertebrates composed the largest group of food items. Eighteen species of chironomids were recovered along with several other aquatic insects. This diet, consisting of many different food items, is characteristic of carp feeding habits.[70]

Stomachs of eight smallmouth buffalo were analyzed and seven were found to contain food items, shown in Table 2.7-206. The food items recovered are similar to those found in the carp. As in the carp, benthic macroinvertebrates comprise the majority of the diet. These fish feed mostly on bottom organisms, copepods, cladocerans and algae.[70]

Data from the stomach content analyses show the variety of organisms comprising the diets of the seven fish species studied. Most species of organisms recovered from the fish stomachs are represented in our plankton and benthic collections which were taken in the same areas where fish were sampled. The presence of an abundance of benthic macroinvertebrates in the stomachs of gizzard shad is different from the data reported by Scott-Crossman[75]; this fish species was reported to be herbaceous.

2.7.2.4.10 ENDANGERED SPECIES

Thus far none of the species collected in the vicinity of the Site by either the aquatic baseline survey or by TVA in 1973[65] have been designated as an endangered species under the Endangered Species Conservation Act of 1969.[78]

TABLE 2.7-1

SOIL TYPES OF THE CLINCH RIVER SITE[6]

Code	Name and Description
Wvx	Waynesboro very fine sandy loam, slope phase
Wvb	Waynesboro very fine sandy loam, eroded hill phase
Nvr	Nolichucky very fine sandy loam, eroded phase
Ws	Wolftever silt loam
Wsx	Wolftever silt loam, slope phase
Tsh	Talbott silty clay loam, smooth phase
Cs	Colbert silty clay loam
Ccl	Clarksville cherty silt loam, hilly phase
Rsc	Rolling stony land, Colbert and Talbott soil material
Us	Upshur silty clay loam, Valley phase
As	Armuchee silt loam
Clx	Colbert silt loam, slope phase
Fc	Fullerton cherty silt loam
Cc	Clarksville cherty silt loam
Sv	Sequatchie very fine sandy loam
Pv	Pope very fine sandy loam
Ccz	Clarksville cherty silt loam, steep phase
Fcr	Fullerton cherty silt loam, eroded phase
Rst	Rough stony land, Talbott soil material
Fct	Fullerton cherty silt loam, eroded hilly phase
Fcz	Fullerton cherty silt loam, steep phase
Ts	Talbott silty clay loam
Ml	Melvin silt loam
Fch	Fullerton cherty silt loam, smooth phase
Gs	Greendale silt loam
Tsl	Talbott silty clay loam, hilly phase
Rg	Roane gravelly loam

(Continued)

TABLE 2.7-1 (Continued)

Code	Name and Description
Lv	Leadvale very fine sandy loam
Cch	Clarksville cherty silt loam, smooth phase
Al	Atkins very fine sandy loam
Fcl	Fullerton cherty silt loam, hilly phase
Rga	Rough gullied land, apison soil material
Ls	Lehew strong fine sandy loam
Avk	Apison very fine sandy loam, eroded slope phase
Rgf	Rough gullied land, Fullerton soil material

TABLE 2.7-2

OVERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Density %	Basal Area / Acre**	Relative Dominance %	Importance Value Index IVI
Quercus velutina (Black oak)	21	75	10.7	25.3	20.1	27.6	21
Quercus prinus (Chestnut oak)	17	100	14.3	20.5	18.9	25.9	20
Acer saccharum (Sugar maple)	9	25	3.6	10.8	5.8	8.0	7
Acer rubrum (Red maple)	6	50	7.1	7.2	2.4	3.3	6
Liriodendron tulipifera (Tulip poplar)	6	50	7.1	7.2	2.3	3.2	6
Quercus alba (White oak)	5	50	7.1	6.0	6.8	9.3	7
Quercus rubra (Red oak)	4	50	7.1	4.8	8.1	11.1	8
Fraxinus americana (White ash)	3	25	3.6	3.6	1.7	2.4	3
Fagus grandifolia (American beech)	2	50	7.1	2.4	0.6	0.8	3

(Continued)

TABLE 2.7-2 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Density %	Basal Area / Acre**	Relative Dominance %	Importance Value Index IVI
Pinus echinata (Shortleaf pine)	2	25	3.6	2.4	0.7	1.0	2
Carya pallida (Sand hickory)	1	25	3.6	1.2	0.4	0.5	2
Carya ovata (Shagbark hickory)	1	25	3.6	1.2	0.4	0.5	2
Carya tomentosa (Mockernut hickory)	1	25	3.6	1.2	0.3	0.4	2
Carya sp (Hickory)	1	25	3.6	1.2	1.0	1.3	2
Quercus coccinea (Scarlet Oak)	1	25	3.6	1.2	1.2	1.7	2
Cornus florida (Flowering dogwood)	1	25	3.6	1.2	0.4	0.5	2
Nyssa silvatica (Black gum)	1	25	3.6	1.2	1.0	1.4	2
Juglans nigra (Black walnut)	1	25	3.6	1.2	0.8	1.1	2
Total	83	700	100.1	99.8	72.9	100.0	99

*One-fifth acre circular plots were utilized for stems larger than 5.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-3

OVERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Relative Density %	Basal Area / Acre**	Relative Dominance %	Importance Value Index IVI
<u>Juniperus virginiana</u> (Red cedar)	10	27.0	22.35	20.9	24
<u>Quercus coccinea</u> (Scarlet oak)	6	16.2	20.45	19.2	18
<u>Fraxinus americana</u> (White ash)	5	13.5	6.15	5.8	10
<u>Quercus alba</u> (White oak)	6	16.2	32.95	30.9	24
<u>Carya ovata</u> (Shagbark hickory)	4	10.8	11.00	10.3	10
<u>Quercus stellata</u> (Post oak)	1	2.7	2.70	2.5	2
<u>Quercus prinus</u> (Chestnut oak)	1	2.7	2.40	2.3	2
<u>Carya tomentosa</u> (Mockernut hickory)	1	2.7	1.15	1.1	2
<u>Ostrya virginiana</u> (Hop hornbeam)	1	2.7	1.35	1.2	2
<u>Acer saccahrum</u> (Sugar maple)	1	2.7	4.75	4.4	4

(Continued)

TABLE 2.7-3 (Continued)

Species	Number of Individuals	Relative Density %	Basal Area / Acre**	Relative Dominance %	Importance Value Index IVI
Liriodendron tulipifera (Tulip poplar)	1	2.7	1.50	1.4	2
Total	37	99.9	106.75	100.0	100

*One-fifth acre circular plots were utilized for stems larger than 5.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-4

OVERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L'

Species	Number of Individuals	Basal Area / Acre	Relative Dominance %	Density / Acre	Relative Density	Importance Value Index IVI
Quercus falcata (Southern red oak)	7	29.7	29.1	35	25.0	27
Quercus alba (White oak)	5	12.8	12.5	25	17.8	15
Liriodendron tulipifera (Tulip poplar)	4	18.2	17.8	20	14.3	16
Quercus coccinea (Scarlet oak)	3	21.6	21.2	15	10.7	16
Fagus grandifolia (American beech)	2	2.8	2.7	10	7.1	5
Fraxinus american (White ash)	2	2.0	1.9	10	7.1	4
Acer rubrum (Red maple)	2	8.2	8.1	10	7.1	8
Carya pallida (Sand hickory)	1	1.4	1.4	5	3.6	3
Pinus virginicana (Virginia pine)	1	3.1	3.0	5	3.6	3
Pinus strobus (White pine)	1	2.3	2.3	5	3.6	3
Total	28	102.1	100.0	140	99.9	100

*One-fifth acre circular plots were utilized for stems larger than 5.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-5

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Sassafras albidum (Sassafras)	40	75	10.3	0.20	31.2	200	31.2	25
Cornus florida (Flowering dogwood)	25	75	10.3	0.12	19.5	125	19.5	16
Carya tomentosa (Mockernut hickory)	13	25	3.4	0.06	10.2	65	10.2	8
Acer rubrum (Red maple)	11	100	13.8	0.05	8.6	55	8.6	10
Nyssa sylvatica (Black gum)	9	75	10.3	0.04	7.0	45	7.0	8
Rhamnus carolinianus (Carolina buckthorn)	6	50	6.9	0.03	4.7	30	4.7	5
Euonymus americanus (American Strawberry-bush)	4	50	6.9	0.02	3.1	20	3.1	4
Carya glabra (Pignut hickory)	3	25	3.4	0.02	2.3	15	2.3	3
Ostrya virginiania (Hop hornbeam)	3	25	3.4	0.02	2.3	15	2.3	3

(Continued)

TABLE 2.7-5 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Prunus serotina (Black cherry)	3	75	10.3	0.02	2.3	15	2.3	5
Quercus alba (White oak)	3	25	3.4	0.02	2.3	15	2.3	3
Oxydendron arboreum (Sourwood)	2	25	3.4	0.01	1.6	10	1.6	2
Vilburnum rufidulum (Rusty blackhaw)	2	24	3.4	0.01	1.6	10	1.6	2
Carya pallida (Sand hickory)	2	25	3.4	0.01	1.6	10	1.6	2
Liriodendron tulipifera (Tulip poplar)	1	25	3.4	0.01	0.8	5	0.8	2
Fraxinus americana (White ash)	1	25	3.4	0.01	0.8	5	0.8	2
Total	128	725	99.4	0.65	99.9	640	99.9	100

*One-twentieth acre circular plots were utilized for stems 0.0 to 0.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-6

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Cornus florida (Flowering dogwood)	4	50	11.1	0.24	18.2	20	18.2	16
Acer rubrum (Red maple)	3	25	5.5	0.18	13.6	15	13.6	11
Rhamnus carolinianus (Carolina buckthorn)	2	50	11.1	0.12	9.1	10	9.1	10
Aesculus sylvatica (Painted buckeye)	1	25	5.5	0.06	4.5	5	4.5	5
Carya tomentosa (Mockernut hickory)	1	25	5.5	0.06	4.5	5	4.5	5
Fraxinus americana (White ash)	1	25	5.5	0.06	4.5	5	4.5	5
Juniperus virginiana (Eastern redcedar)	1	25	5.5	0.06	4.5	5	4.5	5
Nyssa sylvatica (Black gum)	1	25	5.5	0.06	4.5	5	4.5	5
Carya glabra (Pignut hickory)	1	25	5.5	0.06	4.5	5	4.5	5

(Continued)

TABLE 2.7-6 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Oxydendrum arboreum (Sourwood)	1	25	5.5	0.06	4.5	5	4.5	5
Prunus serotina (Black cherry)	1	25	5.5	0.06	4.5	5	4.5	5
Quercus prinus (Chestnut oak)	1	25	5.5	0.06	4.5	5	4.5	5
Ulmus sp. (Elm)	1	25	5.5	0.06	4.5	5	4.5	5
Quercus velutina (Black oak)	1	25	5.5	0.06	4.5	5	4.5	5
Quercus alba (White oak)	1	25	5.5	0.06	4.5	5	4.5	5
Sassafras albidum (Sassafras)	1	25	5.5	0.06	4.5	5	4.5	5
Total	22	450	99.2	1.32	99.4	110	99.4	102

*One-twentieth acre circular plots were utilized for stems 1.0 to 1.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-7

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre **	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Carya glabra (Pignut hickory)	2	25	10	0.34	16.7	10	16.7	14
Oxydendrum arboreum (Sourwood)	2	25	10	0.34	16.7	10	16.7	14
Rhamnus carolinianus (Carolina buckthorn)	2	50	20	0.34	16.7	10	16.7	18
Acer rubrum (Red maple)	1	25	10	0.17	8.3	5	8.3	9
Carya tomentosa (Mockernut hickory)	1	25	10	0.17	8.3	5	8.3	9
Fagus grandifolia (American beech)	1	25	10	0.17	8.3	5	8.3	9
Juniperus virginiana (Eastern redcedar)	1	25	10	0.17	8.3	5	8.3	9
Nyssa sylvatica (Black gum)	1	25	10	0.17	8.3	5	8.3	9
Sassafras albidum (Sassafras)	1	25	10	0.17	8.3	5	8.3	9
Total	12	250	100	2.04	99.9	60	99.9	100

*One-twentieth acre circular plots were utilized for stems 1.0 to 1.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-8

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre **	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Carya glabra (Pignut hickory)	5	50	22.2	1.67	38.5	25	38.5	33
Sassafras albidum (Sassafras)	3	75	33.3	1.01	23.1	15	23.1	26
Acer rubrum (Red maple)	2	25	11.1	0.67	15.4	10	15.4	14
Carya tomentosa (Mockernut hickory)	1	25	11.1	0.34	7.7	5	7.7	9
Liriodendron tulipifera (Tulip poplar)	1	25	11.1	0.34	7.7	5	7.7	9
Quercus alba (White oak)	1	24	11.1	0.34	7.7	5	7.7	9
Total	13	225	99.9	4.37	100.1	65	100.1	100

*One-twentieth acre circular plots were utilized for stems 3.0 to 3.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-9

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre **	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Sassafras albidum (Sassafras)	2	25	12.5	1.10	22.2	10	22.2	19
Carya glabra (Pignut hickory)	2	50	25.0	1.10	22.2	10	22.2	23
Liriodendron tulipifera (Tulip poplar)	1	25	12.5	0.55	11.1	5	11.1	12
Nyssa sylvatica (Black gum)	1	25	12.5	0.55	11.1	5	11.1	12
Quercus prinus (Chestnut oak)	1	25	12.5	0.55	11.1	5	11.1	12
Quercus velutina (Black oak)	1	25	12.5	0.55	11.1	5	11.1	12
Ulmus sp. (Elm)	1	25	12.5	0.55	11.1	5	11.1	12
Total	9	200	100.0	4.95	99.9	45	99.9	102

*One-twentieth acre circular plots were utilized for stems 4.0 to 4.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-10

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Carya glabra (Pignut hickory)	2	50	50	1.65	50	10	50	50
Quercus velutina (Black oak)	1	25	25	0.82	25	5	25	25
Carya tomentosa (Mockernut hickory)	1	25	25	0.82	25	5	25	25
Total	4	100	100	3.29	100	20	100	100

*One-twentieth acre circular plots were utilized for stems 5.0 to 5.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-11

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre**	Relative Density %	Relative Dominance %	Importance Value Index IVI
Acer saccharum (Sugar maple)	24	0.48	37.5	37.5	37
Fraxinus americana (White ash)	21	0.42	32.8	32.8	33
Ostrya virginiana (Hop hornbeam)	7	0.14	10.9	10.9	11
Cercis canadensis (Redbud)	3	0.06	4.7	4.7	5
Carya ovata (Shagbark hickory)	2	0.04	3.1	3.1	3
Ulmus alata (Winged elm)	2	0.04	3.1	3.1	3
Viburnum rufidulum (Rusty blackhaw)	2	0.04	3.1	3.1	3
Acer rubrum (Red maple)	1	0.02	1.6	1.6	2
Aesculus sylvatica Painted buckeye)	1	0.02	1.6	1.6	2
Cornus florida (Flowering dogwood)	1	0.02	1.6	1.6	2
Total	64	1.28	100.0	100.0	101

*One-twentieth acre circular plots were utilized for stems 0.0 to 0.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-12

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre**	Relative Density %	Relative Dominance %	Importance Value Index IVI
Acer saccharum (Sugar maple)	1	0.24	33.3	33.3	33
Cercis canadensis (Red bud)	1	0.24	33.3	33.3	33
Ostrya virginiana (Hop hornbeam)	1	0.24	33.3	33.3	33
Total	3	0.72	99.9	99.9	99

*One-twentieth acre circular plots were utilized for stems 1.0 to 1.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-13

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre**	Relative Density %	Relative Dominance %	Importance Value Index IVI
Ulmus alata (Winged elm)	2	1.36	66.7	66.7	67
Carya ovata (Shagbark hickory)	1	0.68	33.3	33.3	33
Total	3	2.04	100.0	100.0	100

*One-twentieth acre circular plots were utilized for stems 2.0 to 2.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-14

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre **	Relative Density %	Relative Dominance %	Importance Value Index IVI
Acer saccharum (Sugar maple)	1	1.34	50	50	50
Juniperus virginiana (Eastern redcedar)	1	1.34	50	50	50
Total	2	2.68	100	100	100

*One-twentieth acre circular plots were utilized for stems 3.0 to 3.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-15

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre **	Relative Density %	Relative Dominance %	Importance Value Index IVI
Carya ovata (Shagbark hickory)	2	4.40	100	100	100
Total	2	4.40	100	100	100

*One-twentieth acre circular plots were utilized for stems 4.0 to 4.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-16

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre **	Relative Density %	Relative Dominance %	Importance Value Index IVI
Acer saccharum (Sugar maple)	1	3.30	50.0	50.0	50
Quercus prinus (Chestnut oak)	1	3.30	50.0	50.0	50
Total	2	6.60	100.0	100.0	100

*One-twentieth acre circular plots were utilized for stems 5.0 to 5.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-17

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Acer rubrum (Red maple)	10	0.20	24.4	200	24.4	19
Ostrya virginiana (Hop hornbeam)	8	0.16	19.5	160	19.5	16
Oxydendron arboreum (Sourwood)	7	0.14	17.0	140	17.1	14
Fraxinus americana (White ash)	4	0.08	9.8	80	9.8	10
Euonymus americana (Stawberry bush)	3	0.06	7.3	60	7.3	8
Acer saccharum (Sugar maple)	2	0.04	4.9	40	4.9	6
Nyssa sylvatica (Black gum)	2	0.04	4.9	40	4.9	6
Cornus florida (Flowering dogwood)	2	0.04	4.9	40	4.9	6
Fagus grandifolia (American beech)	1	0.02	2.4	20	2.4	5
Liquidambar styraciflua (Sweet gum)	1	0.02	2.4	20	2.4	5
Carya tomentosa (Mockernut hickory)	1	0.02	2.4	20	2.4	5
Total	41	0.82	99.9	820	100.0	100

*One-twentieth acre circular plots were utilized for stems 0.0 to 0.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-18

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Oxydendron arboreum (Sourwood)	3	0.72	42.8	60	42.8	40
Nyssa sylvatica (Black gum)	2	0.48	28.5	40	28.5	30
Vaccinium arboreum (High bush blueberry)	2	0.48	28.5	40	28.5	30
Total	7	1.68	99.8	140	99.8	100

*One-twentieth acre circular plots were utilized for stems 1.0 to 1.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-19

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Oxydendron arboreum (Sourwood)	4	2.72	50.0	80	50.0	41
Vaccinium arboreum (High bush blueberry)	2	1.36	25.0	40	25.0	25
Nyssa sylvatica (Black gum)	1	0.68	12.5	20	12.5	17
Acer rubrum (Red maple)	1	0.68	12.5	20	12.5	17
Total	8	5.44	100.0	160	100.0	100

*One-twentieth acre circular plots were utilized for stems 2.0 to 2.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-20

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Acer saccharum (Sugar maple)	1	1.34	33.3	20	33.3	33
Acer rubrum (Red maple)	1	1.34	33.3	20	33.3	33
Liquidambar styraciflua (Sweet gum)	1	1.34	33.3	20	33.3	33
Total	3	4.02	99.9	60	99.9	99

*One-twentieth acre circular plots were utilized for stems 3.0 to 3.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-21

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre**	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Oxydendron arboreum (Sourwood)	2	4.4	66.7	40	66.7	61
Acer rubrum (Red maple)	1	2.2	33.3	20	33.3	39
Total	3	6.6	100.0	60	100.0	100

*One-twentieth acre circular plots were utilized for stems 4.0 to 4.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-22

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Basal Area / Acre	Relative Dominance %	Density / Acre	Relative Density %	Importance Value Index IVI
Quercus alba (White oak)	1	3.3	100	20	100	100
Total	1	3.3	100	20	100	100

*One-twentieth acre circular plots were utilized for stems 5.0 to 5.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-23

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA K

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Sassafras albidum (Sassafras)	21	100	9.3	16.0	12.5	18.2	15
Acer saccharum (Sugar maple)	16	25	2.3	12.2	10.0	14.5	10
Vaccinium stamineum (Deerberry)	13	25	2.3	9.9	8.0	11.6	8
Cercis canadensis (Redbud)	11	25	2.3	8.4	4.0	5.8	6
Acer rubrum (Red maple)	9	50	4.7	6.9	5.0	7.2	6
Asplenium platyneuron (Ebony spleenwort)	6	25	2.3	4.6	3.0	4.3	4
Smilax glauca (Sawbrier)	6	75	7.0	4.6	1.0	1.4	4
Quercus prinus (Chestnut oak)	6	50	4.7	4.6	5.0	7.2	6
Ostrya virginiana (Hop hornbeam)	5	50	4.7	3.8	1.5	2.1	4

(Continued)

TABLE 2.7-23 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Carya sp (Hickory)	4	75	7.0	3.0	1.0	1.4	4
Quercus velutina (Black oak)	3	25	2.3	2.3	1.0	1.4	2
Smilacina racemosa (False solomon's-seal)	3	25	2.3	2.3	3.0	4.3	3
Geum canadense (White avens)	3	25	2.3	2.3	0.5	0.7	2
Rhus radicans (Poison-ivy)	3	25	2.3	2.3	2.0	2.9	2
Quercus rubra (Red oak)	2	25	2.3	1.5	0.5	0.7	1
Quercus alba (White oak)	2	25	2.3	1.5	1.0	1.4	2
Chimaphila maculata (Spotted wintergreen)	2	50	4.7	1.5	1.5	2.1	3
Cornus florida (Flowering dogwood)	2	50	4.7	1.5	1.0	1.4	2

(Continued)

TABLE 2.7-23 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Parthenocissus quinquefolia (Virginia creeper)	2	25	2.3	1.5	1.0	1.4	3
Vitis rotundifolia (Wild grape)	2	50	4.7	1.5	1.0	1.4	2
Carya glabra (Pignut hickory)	1	25	2.3	0.8	0.5	0.7	1
Carya pallida (Sand hickory)	1	25	2.3	0.8	0.5	0.7	1
Carya tomentosa (Mockernut hickory)	1	25	2.3	0.8	1.0	1.4	1
Rubus sp (Blackberry)	1	25	2.3	0.8	0.5	0.7	1
Fraxinus americana (White ash)	1	25	2.3	0.8	0.5	0.7	1
Conopholis americana (Squawroot)	1	25	2.3	0.8	0.5	0.7	1
Hepatica acutiloba (Sharp-lobed hepatica)	1	25	2.3	0.8	1.0	1.4	2

(Continued)

TABLE 2.7-23 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Liriodendron tulipifera (Tulip poplar)	1	25	2.3	0.8	0.5	0.7	1
Oxydendrum arboreum (Sourwood)	1	25	2.3	0.8	0.5	0.7	1
Unknown grass	1	25	2.3	0.8	0.5	0.7	1
Total	131	1075	99.8	100.2	68.5	99.8	100

*One-thousandth acre circular plots were utilized

TABLE 2.7-24

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*
MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Acer saccharum (Sugar maple)	21	28.8	15.0	37.5	33
Cercis canadensis (Redbud)	16	21.9	5.0	12.5	17
Ostrya virginiana (Hop hornbeam)	9	12.3	5.0	12.5	12
Lonicera japonica (Japanese honeysuckle)	7	9.6	5.0	12.5	11
Polypodium virginianum (Common polypody)	5	6.8	0.5	1.2	4
Asplenium platyneuron (Ebony spleenwort)	4	5.5	0.5	1.2	4
Geum canadense (White avens)	2	2.7	0.5	1.2	2
Vitis rotundifolia (Wild grape)	1	1.4	0.5	1.2	2
Cornus florida (Flowering dogwood)	1	1.4	0.5	1.2	1
Bignonia capreolata (Crossvine)	1	1.4	0.5	1.2	1

(Continued)

TABLE 2.7-24 (Continued)

Species	Number of Individuals	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Smilacina racemosa (False Solomon's-seal)	1	1.4	0.5	1.2	1
Rhamnus carolinianus (Carolina buckthorn)	1	1.4	0.5	1.2	1
Celtis laevigata (Lowland hackberry)	1	1.4	0.5	1.2	1
Galium aparine (Cleavers)	1	1.4	0.5	1.2	1
Prunus serotina (Black cherry)	1	1.4	0.5	1.2	1
Viburnum rufidulum (Rusty blackhaw)	1	1.4	5.0	12.5	7
Total	73	100.2	40.5	100.7	99

*One-thousandth acre circular plots were utilized

TABLE 2.7-25

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA L

Species	Number of Individuals	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Euonymus americanus (American Strawberry-bush)	17	26.1	5.0	21.3	24
Cercis canadensis (Redbud)	14	21.5	0.5	2.1	12
Acer rubrum (Red maple)	7	10.8	5.0	21.3	16
Chimaphila maculata (Spotted wintergreen)	4	6.1	0.5	2.1	4
Acer saccharum (Sugar maple)	3	4.6	0.5	2.1	3
Carya tomentosa (Mockernut hickory)	3	4.6	1.0	4.3	4
Tipularia discolor (Crainfly orchid)	2	3.1	1.0	4.3	4
Viburnum rufidulum (Rusty blackhaw)	2	3.1	1.0	4.3	4
Rubus sp. (Blackberry)	2	3.1	0.5	2.1	3
Quercus velutina (Black oak)	2	3.1	1.0	4.3	4

(Continued)

TABLE 2.7-25 (Continued)

Species	Number of Individuals	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Podophyllum peltatum (May apple)	2	3.1	3.0	12.8	8
Smilacina racemosa (False Soloman's-seal)	2	3.1	2.0	8.5	6
Ostrya virginiana (Hop hornbeam)	1	1.5	0.5	2.1	2
Viola sp. (Violet)	1	1.5	0.5	2.1	2
Vitis rotundifolia (Wild grape)	1	1.5	0.5	2.1	2
Fraxinus americana (White ash)	1	1.5	0.5	2.1	2
Smilax glauca (Sawbrier)	1	1.5	0.5	2.1	2
Total	65	99.8	23.5	100.0	102

*One-thousandth acre circular plots were utilized

TABLE 2.7-26

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA A

Species	Number of Individuals	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Sassafras albidum (Sassafras)	11	31.4	9.0	10.0	21
Nyssa sylvatica (Black gum)	3	8.6	4.0	4.0	6
Prunus serotina (Black cherry)	3	8.6	10.0	11.0	10
Smilax sp. (Greenbrier)	3	8.6	1.0	1.0	5
Liriodendron tulipifera (Tulip poplar)	3	8.6	1.0	1.0	5
Vitis rotundifolia (Wild grape)	2	5.7	1.0	1.0	4
Parthenocissus quinquefolia (Virginia creeper)	1	2.9	45.0	50.0	26
Vitis sp. (Wild grape)	1	2.9	3.0	3.0	3
Asclepias sp. (Milkweed)	1	2.9	1.0	1.0	2
Carya tomentosa (Mockernut hickory)	1	2.9	8.0	9.0	6
Carya sp. (Hickory)	1	2.9	2.0	2.0	2

(Continued)

TABLE 2.7-26 (Continued)

Species	Number of Individuals	Relative Density %	Cover %	Relative Cover %	Importance Value Index IVI
Acer saccharum (Sugar maple)	1	2.9	1.0	1.0	2
Podophyllum peltatum (May apple)	1	2.9	1.0	1.0	2
Smilacina racemosa (False Solomon's-seal)	1	2.9	1.0	1.0	2
Liquidambar styraciflua (Sweet gum)	1	2.9	1.0	1.0	2
Quercus rubra (Red oak)	1	2.9	1.0	1.0	2
Total	35	101.0	90.0	98.0	100

*One-thousandth acre circular plots were utilized

TABLE 2.7-27

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA D

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Panicum sp. (Panic grass)	10	1.0	3.2	13.5	9
Cercis canadensis (Redbud)	9	4.0	12.9	12.2	13
Smilax sp. (Greenbrier)	7	1.0	3.2	9.5	6
Chimaphila maculata (Spotted wintergreen)	6	1.0	3.2	8.1	6
Galium sp. (Bedstraw)	5	1.0	3.2	6.8	5
Carya sp. (Hickory)	5	1.0	3.2	6.8	5
Quercus rubra (Red oak)	4	1.0	3.2	5.4	4
Acer saccharum (Sugar maple)	3	3.0	9.7	4.0	7
Quercus alba (White oak)	3	1.0	3.2	4.0	4

(Continued)

TABLE 2.7-27 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Asplenium platyneuron (Ebony spleenwort)	3	1.0	3.2	4.0	4
Liriodendron tulipfera (Tulip tree)	2	1.0	3.2	2.7	3
Carex sp. (Sedge)	2	1.0	3.2	2.7	3
Acer rubrum (Red maple)	1	1.0	3.2	1.3	2
Aristolochia serpentaria (Virginia snakeroot)	2	1.0	3.2	2.7	3
Sassafras albidum (Sassafras)	2	1.0	3.2	2.7	3
Geum canadense (White avens)	2	1.0	3.2	2.7	3
Quercus falcata (Southern red oak)	1	1.0	3.2	1.3	2
Dioscorea villosa (Wild yam)	1	2.0	6.4	1.3	4

(Continued)

TABLE 2.7-27 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Hexastylis arifolia (Little brown jug)	1	1.0	3.2	1.3	2
Rhamnus carolinianus (Carolina buckthorn)	1	1.0	3.2	1.3	2
Lonicera japonica (Japanese honeysuckle)	1	1.0	3.2	1.3	2
Cornus florida (Flowering dogwood)	1	2.0	6.4	1.3	4
Vitis sp. (Wild grape)	1	1.0	3.2	1.3	2
Leguninosae (Unknown species)	1	1.0	3.2	1.3	2
Total	74	31.0	99.4	99.5	100

*One-thousandth acre circular plots were utilized

TABLE 2.7-28

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

MIXED HARDWOOD COMMUNITY AREA J

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Desmodium sp. (Sticktights)	61	100	4.5	21.0	12.9	16.1	11
Sassafras albidium (Sassafras)	34	100	4.5	16.0	9.8	8.9	8
Lonicera japonica (Japanese honeysuckle)	32	33	1.5	2.0	1.2	8.9	4
Parthenocissus quinquefolia (Virginia creeper)	26	100	4.5	6.0	3.6	6.8	5
Euonymus obovatus (Running strawberry-bush)	26	33	1.5	4.0	2.4	6.8	3
Smilax sp. (Greenbriar)	22	67	3.0	2.5	1.5	5.8	3
Hexastylis arifolia (Little brown jug)	19	67	3.0	7.0	4.3	5.0	4
Prunus serotina (Black cherry)	13	100	4.5	5.0	3.0	3.4	3
Panicum sp. (Panic grass)	13	33	1.5	1.5	0.9	3.4	2

(Continued)

TABLE 2.7-28 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Cercis canadensis (Redbud)	8	33	1.5	0.5	0.3	2.1	1
Polygonatum biflorum (Common solomon's-seal)	8	33	1.5	0.5	0.3	2.1	1
Chimaphila maculata (Spotted wintergreen)	8	67	3.0	1.0	0.6	2.1	2
Quercus rubra (Red oak)	7	33	1.5	8.0	4.9	1.8	3
Liriodendron tulipfera (Tulip poplar)	7	67	3.0	0.5	0.3	1.8	2
Smilacina sp. (False Solomon's-seal)	7	33	1.5	4.0	2.4	1.8	2
Galium circaezans (Bedstraw)	6	33	1.5	0.5	0.3	1.6	1
Carya sp. (Hickory)	6	100	4.5	11.5	7.0	1.6	4
Acer rubrum (Red maple)	6	67	3.0	1.5	0.9	1.6	2

(Continued)

TABLE 2.7-28 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Quercus alba (White oak)	5	67	3.0	1.5	0.9	1.3	2
Viola triloba (Three-lobed violet)	5	33	1.5	0.5	0.3	1.3	1
Rhamnus carolinianus (Carolina buckthorn)	5	67	3.0	0.5	0.3	1.3	2
Aristolochia serpentaria (Virginia snakeroot)	4	33	1.5	0.5	0.3	1.1	1
Vitis sp. (Wild grape)	4	67	3.0	1.5	0.9	1.1	2
Oxydendron arboreum (Sourwood)	4	33	1.5	5.0	3.0	1.1	2
Quercus sp. (Oak seedling)	3	67	3.0	6.5	4.0	0.8	3
Viola sp. (Violet)	3	33	1.5	0.5	0.3	0.8	1
Viola hirsutula	3	33	1.5	0.5	0.3	0.8	1

(Continued)

TABLE 2.7-28 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Grass sp.	3	33	1.5	0.5	0.3	0.8	1
Cornus florida (Flowering dogwood)	3	67	3.0	35.0	21.5	0.8	8
Dioscorea quaternata (Wild yam)	3	33	1.5	2.0	1.2	0.8	1
Vaccinium vascillans	3	33	1.5	0.5	0.3	0.8	1
Juniperus virginiana (Eastern redcedar)	3	33	1.5	1.0	0.6	0.8	1
Vitis rotundifolia (Wild grape)	3	33	1.5	3.0	1.8	0.8	1
Carex sp. (Sedge)	2	33	1.5	0.5	0.3	0.5	1
Amelanchier sp. (Serviceberry)	2	67	3.0	0.5	0.3	0.5	1
Euonymus americanus (American strawberry bush)	2	33	1.5	1.0	0.6	0.5	1

(Continued)

TABLE 2.7-28 (Continued)

Species	Number of Individuals	Frequency	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Scutellaria elliptica (Hairy skullcap)	2	33	1.5	1.0	0.6	0.5	1
Smilax glauca (Sawbrier)	2	33	1.5	1.0	0.6	0.5	1
Veronica serpyllifolia (Thyme-leaved speedwell)	1	33	1.5	0.5	0.3	0.3	1
Geum canadense (White avens)	1	33	1.5	0.5	0.3	0.3	1
Nyssa sylvatica (Black gum)	1	33	1.5	2.5	1.5	0.3	1
Ipomoea sp. (Morning glory)	1	33	1.5	0.5	0.3	0.3	1
Asplenium platyneuron (Ebony spleenwort)	1	33	1.5	0.5	0.3	0.3	1
Ilex opaca (American holly)	1	33	1.5	0.5	0.3	0.3	1
Convolvulus sp. (Bindweed)	1	33	1.5	0.5	0.3	0.3	1
Lespedeza procumbens (Bush clover)	1	33	1.5	1.0	0.6	0.3	1
Total	381	2227	100.5	162.5	98.9	100.9	102

*One-thousandth acre circular plots were utilized

TABLE 2.7-29

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

NATURAL PINE COMMUNITY AREA C

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Quercus falcata (Southern red oak)	8	3.0	3.0	17.0	10
Potentilla canadensis (Canadian cinquefoil)	4	1.0	1.0	8.5	5
Actinomeris alternifolia (Angle stem)	4	1.0	1.0	8.5	5
Fraxinus americana (White ash)	3	4.0	4.0	6.4	5
Galium sp. (Bedstraw)	2	1.0	1.0	4.3	2
Chimaphila maculata (Spotted wintergreen)	2	1.0	1.0	4.3	2
Rhus radicans (Poison ivy)	2	1.0	1.0	4.3	2
Carya sp. (Hickory)	2	3.0	3.0	4.3	4
Goodyera pubescens (Downy rattlesnake plantain)	2	1.0	1.0	4.3	2

(Continued)

TABLE 2.7-29 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Senecio smalli (Small's ragwort)	2	1.0	1.0	4.3	2
Acer rubrum (Red maple)	2	1.0	1.0	4.3	2
Cornus florida (Flowering dogwood)	2	3.0	3.0	4.3	4
Smilax spp. (Greenbrier)	2	1.0	1.0	4.3	2
Asplenium platyneuron (Ebony spleenwort)	1	1.0	1.0	2.1	2
Lonicera japonica (Japanese honeysuckle)	1	70.0	69.3	2.1	36
Quercus muhlenbergii (Yellow oak)	1	1.0	1.0	2.1	2
Lespedeza sp. (Bush clover)	1	1.0	1.0	2.1	2
Erianthus sp. (Plume grass)	1	1.0	1.0	2.1	2

(Continued)

TABLE 2.7-29 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Prunus serotina (Black cherry)	1	1.0	1.0	2.1	2
Rhamnus carolinianus (Carolina buckthorn)	1	1.0	1.0	2.1	2
Lactuca spp. (Wild lettuce)	1	1.0	1.0	2.1	2
Carex sp. (Sedge)	1	1.0	1.0	2.1	2
Hieracium sp. (Hawkweed)	1	1.0	1.0	2.1	2
Total	47	101.0	100.3	100.1	101

*One-thousandth acre circular plots were utilized

TABLE 2.7-30

WOODY AND HERBACEOUS GROUND COVER VEGETATION DATA OF THE CLINCH RIVER SITE*

NATURAL PINE COMMUNITY AREA G

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Lonicera japonica (Japanese honeysuckle)	19	4.0	22.2	28.8	26
Geum canadense (White avens)	17	2.0	11.1	25.8	18
Smilax sp. (Greenbrier)	12	1.0	5.5	18.2	11
Rhus radicans (Poison ivy)	7	1.0	5.5	10.6	8
Cornus florida (Flowering dogwood)	2	1.0	5.5	3.0	4
Rhamnus carolinianus (Carolina buckthorn)	1	1.0	5.5	1.5	4
Celtis sp. (Hackberry)	1	1.0	5.5	1.5	4
Vitis rotundifolia (Wild grape)	1	1.0	5.5	1.5	4
Nyssa sylvatica (Black gum)	1	1.0	5.5	1.5	4

(Continued)

TABLE 2.7-30 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Galium sp. (Bedstraw)	1	1.0	5.5	1.5	4
Prunus serotina (Black cherry)	1	1.0	5.5	1.5	4
Solidago sp. (Goldenrod)	1	1.0	5.5	1.5	4
Quercus alba (White oak)	1	1.0	5.5	1.5	4
Parthenocissus quinquefolia (Virginia creeper)	1	1.0	5.5	1.5	4
Total	66	18.0	99.3	99.9	103

*One-thousandth acre circular plots were utilized

TABLE 2.7-31

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

NATURAL PINE COMMUNITY AREA H

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Campsis radicans (Trumpet creeper)	11	20	35.1	23.4	29
Lonicera japonica (Japanese honeysuckle)	10	25	43.9	21.3	33
Asplenium platyneuron (Ebony spleenwort)	6	2	3.5	12.8	8
Cornus florida (Flowering dogwood)	5	1	1.7	10.6	6
Rhus radicans (Poison ivy)	4	2	3.5	8.5	6
Carex sp. (Sedge)	3	1	1.7	6.4	4
Fragaria virginiana (Wild strawberry)	2	1	1.7	4.3	3
Smilax glauca (Greenbrier)	2	1	1.7	4.3	3
Actinomeris alternifolia (Angel stem)	1	1	1.7	2.1	2
Eulalia riminea (Eulalia)	1	1	1.7	2.1	2

(Continued)

TABLE 2.7-31 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Prunus serotina (Black cherry)	1	1	1.7	2.1	2
Rubus sp. (Blackberry)	1	1	1.7	2.1	2
Total	47	57	99.6	100.0	100

*One-thousandth acre circular plots were utilized

TABLE 2.7-32

OVERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

WHITE PINE PLANTATION AREA I

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Density %	Relative Dominance %	Basal Area / Acre**	Importance Value Index IVI
Pinus strobus (White pine)	51	100	25.0	83.6	81.8	52.05	63
Pinus echinata (Shortleaf pine)	5	100	25.0	8.2	7.9	5.06	14
Sassafras albidum (Sassafras)	2	50	12.5	3.3	1.7	1.10	6
Pinus taeda (Loblolly pine)	1	50	12.5	1.6	4.0	2.52	6
Liriodendron tulipifera (Tulip poplar)	1	50	12.5	1.6	1.3	0.83	5
Liquidambar styraciflua (Sweet gum)	1	50	12.5	1.6	3.3	2.10	6
Total	61		100.0	99.9	100.0	63.66	100

*One-fifth acre circular plots were utilized for stems larger than 5.9 inches at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-33

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

WHITE PINE PLANTATION AREA I

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Dominance %	Relative Density %	Basal Area / Acre**	Importance Value Index IVI
Cornus florida (Flowering dogwood)	9	100	66.7	90	90	1.08	82
Pinus strobus (White pine)	1	50	33.3	10	10	0.12	18
Total	10		100.0	100	100	1.20	100

*One-twentieth acre plots were utilized for stems 1.0 to 1.5 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-34

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

WHITE PINE PLANTATION AREA I

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Dominance %	Relative Density %	Basal Area / Acre**	Importance Value Index IVI
Cornus florida (Flowering dogwood)	9	100	33.3	56.2	56.2	3.06	49
Pinus strobus (White pine)	4	100	33.3	25.0	25.0	1.36	28
Rhamnus carolinianus (Carolina buckthorn)	2	50	16.7	12.5	12.5	0.68	14
Diospyros virginiana (Persimmon)	1	50	16.7	6.2	6.2	0.34	10
Total	16		100.0	99.9	99.9	5.40	101

*One-twentieth acre circular plots were utilized for stems 2.0 to 2.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-35

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
WHITE PINE PLANTATION AREA I

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Dominance %	Relative Density %	Basal Area / Acre**	Importance Value Index IVI
Pinus strobus (White pine)	6	100	40.0	50.0	50.0	4.02	47
Cornus florida (Flowering dogwood)	3	50	20.0	25.0	25.0	2.01	23
Diospyros virginiana (Persimmon)	2	50	20.0	16.7	16.7	1.34	18
Acer rubrum (Red maple)	1	50	20.0	8.3	8.3	0.67	12
Total	12		100.0	100.0	100.0	8.04	100

*One-twentieth acre circular plots were utilized for stems 3.0 to 3.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-36

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*

WHITE PINE PLANTATION AREA I

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Dominance %	Relative Density %	Basal Area / Acre**	Importance Value Index IVI
Pinus strobus (White pine)	9	100	50.0	64.3	64.3	9.90	60
Diospyros virginiana (Persimmon)	5	100	50.0	35.7	35.7	5.50	40
Total	14		100.0	100.0	100.0	15.40	100

*One-twentieth acre plots were utilized for stems 4.0 to 4.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-37

WOODY UNDERSTORY VEGETATION DATA OF THE CLINCH RIVER SITE*
WHITE PINE PLANTATION AREA I

Species	Number of Individuals	Frequency %	Relative Frequency %	Relative Dominance %	Relative Density %	Basal Area / Acre**	Importance Value Index IVI
Pinus strobus (White pine)	5	100	66.7	83.3	83.3	8.25	78
Sassafras albidum (Sassafras)	1	50	33.3	16.7	16.7	1.65	22
Total	6	150	100.0	100.0	100.0	9.90	100

*One-twentieth acre circular plots were utilized for stems 5.0 to 5.9 inches in diameter at 4.5 feet above the soil

**Basal area is recorded in square feet

TABLE 2.7-38

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*
WHITE PINE PLANTATION AREA I

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Lonicera japonica (Japanese honeysuckle)	12	100	15.4	1.0	15.4	35.3	22
Tipularia discolor (Crane-fly orchid)	4	100	15.4	1.0	15.4	11.8	14
Smilax glauca (Sawbrier)	3	50	7.7	0.5	7.7	8.8	8
Liqustrum sineuse (Privet)	3	100	15.4	1.0	15.4	8.8	13
Rhus radicans (Poison ivy)	3	50	7.7	0.5	7.7	8.8	8
Asplenium platyneuron (Ebony spleenwort)	2	50	7.7	0.5	7.7	6.0	7
Sassafras albidum (Sassafras)	2	50	7.7	0.5	7.7	6.0	7
Parthenocissis quinquefolia (Virginia creeper)	2	50	7.7	0.5	7.7	6.0	7
Rubus sp. (Blackberry)	2	50	7.7	0.5	7.7	6.0	7
Cornus florida (Flowering dogwood)	1	50	7.7	0.5	7.7	2.9	6
Total	34		100.1	6.5	100.1	100.4	99

*One-thousandth acre circular plots were utilized

TABLE 2.7-39

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*
CEDAR GLADE COMMUNITY AREA E

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Triodia flava (Purpletop)	50	50	2.0	1	1.1	14.2	6
Lespedeza sp. (Bush clover)	43	100	4.0	9	9.8	12.2	9
Houstonia tenuifolia (Slender-leaved summer bluet)	31	100	4.0	2	2.2	8.8	5
Fragaria virginian (Wild strawberry)	28	50	2.0	3	3.3	7.9	4
Daucus carota (Queen Anne's lace)	26	50	2.0	1	1.1	7.4	4
Salvia lyrata (Lyre-leafed sage)	23	50	2.0	5	5.4	6.5	5
Desmodium sp. (Stick tights)	22	50	2.0	25	27.2	6.2	12
Chrysanthemum leucanthemum (Ox-eye daisy)	17	100	4.0	2	2.2	4.8	4
Prunella vulgaris (Self-heal)	13	50	2.0	3	3.3	3.7	3

(Continued)

TABLE 2.7-39 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Grass sp. (Unknown)	11	50	2.0	1	1.1	3.1	2
Verbena sp. (Vervain)	7	50	2.0	1	1.1	2.0	2
Albizia julibrissin (Silk tree)	6	50	2.0	1	1.1	1.7	2
Plantago sp. (Plantain)	6	50	2.0	1	1.1	1.7	2
Geum canadensis (White avens)	5	50	2.0	1	1.1	1.4	2
Juniperus virginiana (Eastern redcedar)	5	100	4.0	2	2.2	1.4	3
Euphorbia corollata (Flowering spurge)	4	50	2.0	4	4.3	1.1	2
Galium sp. (Bedstraw)	4	50	2.0	1	1.1	1.1	1
Lonicera japonica (Japanese honeysuckle)	4	50	2.0	1	1.1	1.1	1

(Continued)

TABLE 2.7-39 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Panicum sp. (Panic grass)	4	50	2.0	1	1.1	1.1	1
Rhus radicans (Poison ivy)	4	100	4.0	2	2.2	1.1	2
Senecio smalli (Small's ragwort)	4	50	2.0	1	1.1	1.1	1
Erianthus sp. (Plume grass)	3	50	2.0	1	1.1	0.8	1
Oxalis sp. (Wood sorrel)	3	100	4.0	2	2.2	0.8	2
Oenothera sp. (Evening primrose)	3	50	2.0	1	1.1	0.8	1
Leguninosae (Viny legume)	3	50	2.0	1	1.1	0.8	1
Andropogon virginicus (Broomsedge)	2	50	2.0	1	1.1	0.6	1
Carex sp. (Sedge)	2	50	2.0	1	1.1	0.6	1
Cercis canadensis (Redbud)	2	100	4.0	2	2.2	0.6	2

(Continued)

TABLE 2.7-39 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Erigeron sp. (Fleabane)	2	50	2.0	1	1.1	0.6	1
Lespedeza sp (Bush clover)	2	50	2.0	1	1.1	0.6	1
Rhamnus carolinianus (Carolina buckthorn)	2	50	2.0	1	1.1	0.6	1
Solidago sp. (Goldenrod)	2	100	4.0	2	2.2	0.6	2
Ailanthus altissima (Tree-of-heaven)	1	50	2.0	1	1.1	0.3	1
Anemone sp. (Wood anemone)	1	50	2.0	1	1.1	0.3	1
Actinomeris alternifolia (Angle stem)	1	50	2.0	1	1.1	0.3	1
Carduus sp. (Thistle)	1	50	2.0	1	1.1	0.3	1
Nyssa sylvatia (Black gum)	1	50	2.0	1	1.1	0.3	1
Prunus sp. (Cherry)	1	50	2.0	1	1.1	0.3	1

(Continued)

TABLE 2.7-39 (Continued)

Species	Number of Individuals	Frequency %	Relative Frequency %	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Quercus falcata (Southern red oak)	1	50	2.0	1	1.1	0.3	1
Quercus muehlenbergii (Yellow oak)	1	50	2.0	1	1.1	0.3	1
Ruellia sp. (Wild petunia)	1	50	2.0	1	1.1	0.3	1
Smilax sp. (Greenbrier)	1	50	2.0	1	1.1	0.3	1
Total	353		100.0	92	100.6	100.0	97

*One-thousandth acre circular plots were utilized

TABLE 2.7-40

WOODY AND HERBACEOUS GROUND COVER DATA OF THE CLINCH RIVER SITE*

HARDWOOD-CEDAR COMMUNITY AREA F

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Euphorbia corollata (Flowering spurge)	19	1	1.2	15.3	8
Potentilla simplex (Canada cinquefoil)	18	1	1.2	14.5	8
Fragaria virginiana (Wild strawberry)	15	1	1.2	12.1	6
Geum candense (White avens)	10	1	1.2	8.1	4
Cercis canadensis (Redbud)	8	1	1.2	6.5	4
Actinomeris alternifolia (Angel stem)	7	1	1.2	5.6	4
Desmodium sp. (Sticktight)	6	4	4.9	4.8	5
Panicum sp. (Panic grass)	5	1	1.2	4.0	2
Penstemon sp. (Beard tongue)	4	1	1.2	3.2	2

(Continued)

TABLE 2.7-40 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Quereus muehlenbergii (Yellow oak)	4	2	2.4	3.2	3
Carex sp. (Sedge)	3	1	1.2	2.4	2
Celtis sp. (Hackberry)	3	1	1.2	2.4	2
Compositae (seedling)	2	1	1.2	1.6	2
Hustonia tenuifoila (Slender-leaved summer bluet)	2	1	1.2	1.6	2
Lespedeza sp. (Bush clover)	2	1	1.2	1.6	2
Solidago sp. (Goldenrod)	2	1	1.2	1.6	2
Unknown (seedlings)	2	1	1.2	1.6	2
Viola sp. (Violet)	2	1	1.2	1.6	2
Ceanothus americanus (New Jersey tea)	1	2	2.4	0.8	2

(Continued)

TABLE 2.7-40 (Continued)

Species	Number of Individuals	Cover %	Relative Cover %	Relative Density %	Importance Value Index IVI
Galium aparionl (Cleaver)	1	1	1.2	0.8	1
Juniperus virginiana (Eastern redcedar)	1	1	1.2	0.8	1
Lonicera japonica (Japanese honeysuckle)	1	50	61.0	0.8	30
Pycnanthemum pycoranthemoides (Wild mint)	1	1	1.2	0.8	1
Ruellia sp. (Wild petunia)	1	1	1.2	0.8	1
Senecio smalli (Small's ragwort)	1	1	1.2	0.8	1
Spigelia marilandica (Indian pink)	1	1	1.2	0.8	1
Ulmus alta (Winged elm)	1	1	1.2	0.8	1
Unknown composite	1	1	1.2	0.8	1
Total	124	82	99.5	99.7	102

*One-thousandth acre circular plots were utilized

TABLE 2.7-41

WOODY PLANT COMMUNITIES AFFECTED BY THE PROPOSED TRANSMISSION ROUTE

Overstory Communities	Coverage*	
	Acres	%
Hardwood	23.0	39.6
Pine plantation	12.1	20.7
Natural pine	10.2	17.6
Hardwood-natural pine-cedar	5.5	9.4
Unforested	4.6	7.8
Hardwood-natural pine	1.4	2.4
Hardwood-cedar	0.9	1.6
Pine plantation-cedar	0.3	0.6
Natural pine-cedar	0.2	0.3
Total	58.2	100.0

*Area affected by the proposed transmission route = 3.2 miles x 150 feet wide = 58.2 acres.

TABLE 2.7-42

WOODY PLANT COMMUNITIES POTENTIALLY AFFECTED BY THE ALTERNATIVE TRANSMISSION ROUTE

Overstory Communities	Coverage* Acres	%
Unforested	16.9	27.4
Natural pine	15.2	24.6
Pine plantation	13.6	22.0
Hardwood	12.4	20.0
Hardwood-cedar	1.0	1.7
Hardwood-natural pine-cedar	1.0	1.7
Natural pine-cedar	0.9	1.4
Hardwood-natural pine	0.5	0.8
Cedar	0.3	0.4
Total	61.8	100.0

*Potential area affected by the alternate transmission route = 3.4 miles x 150 feet wide = 61.8 acres.

TABLE 2.7-43

PLANT COMMUNITIES AND COVER TYPES ALONG THE PROPOSED CLINCH RIVER TRANSMISSION ROUTE

I. Hardwood Community
   - White oak--red oak--hickory
   - Red oak--mockernut hickory--sweetgum
   - Yellow poplar--white oak--northern red oak
   - Sweetgum--yellow poplar
   - Post oak--blackjack oak
   - Scarlet oak

II. Hardwood--Natural Pine--Cedar Community

III. Natural Pine Community
   - Shortleaf pine--Virginia pine
   - Virginia pine
   - Loblolly pine--shortleaf pine
   - Loblolly pine

IV. Open Community

V. Hardwood--Natural Pine Community
   - Loblolly pine--hardwood
   - Virginia pine--southern red oak

VI. Pine Plantation

VII. Hardwood--Cedar Community

VIII. Pine Plantation--Cedar Community

IX. Natural Pine--Cedar Community

TABLE 2.7-44

PLANT COMMUNITIES AND COVER TYPES ALONG THE ALTERNATE CLINCH RIVER TRANSMISSION ROUTE

I. Natural Pine Community
   - Shortleaf pine--Virginia pine
   - Virginia pine
   - Loblolly pine--shortleaf pine
   - Loblolly pine

II. Hardwood Community
   - White oak--red oak--hickory
   - Northern red oak--mockernut hickory--sweetgum
   - Yellow poplar--white oak--northern red oak
   - Sweetgum--yellow poplar
   - Post oak--blackjack oak
   - Scarlet oak

III. Open Community

IV. Pine Plantation

V. Hardwood--Natural Pine--Cedar Community

VI. Natural Pine--Cedar Community

VII. Hardwood--Cedar Community

VIII. Hardwood--Natural Pine Community
   - Loblolly pine--hardwood
   - Virginia pine--southern red oak

IX. Cedar Community

TABLE 2.7-45

OVERSTORY AND UNDERSTORY ASSOCIATIONS ON THE PROPOSED CLINCH RIVER TRANSMISSION ROUTE

Hardwood	Natural Pine	Pine Plantation	Cedar	Open
		OVERSTORY		
Sugar maple	Loblolly pine	Loblolly pine	Eastern red cedar	
Red maple	White pine			
Silver maple	Virginia pine			
Red oak				
Yellow oak				
White oak				
Post oak				
Black jack oak				
Sweet gum				
Black gum				
Sourwood				
White ash				
American elm				
Slippery elm				
Mockernut hickory				
Black walnut				
Tulip poplar				
Black cherry				
Sycamore				
		UNDERSTORY		
Red maple	Dogwood	Eastern redcedar	White pine	American basswood
Sugar maple	Black cherry	Loblolly pine	Black cherry	Black cherry
Eastern redcedar	Red maple	Black cherry	Winged dogwood	Eastern redcedar
Black walnut	Tulip poplar	Winged sumac	Black gum	Flowering dogwood
Sassafras	American elm	Sassafrass	White ash	Gray dogwood
White ash	Loblolly pine	Smooth sumac		Redbud
American elm	Sweet gum	Black gum		
Red oak	Redbud	Elm		
Bitternut hickory	Paw paw	Dogwood		
Sweet gum	Sourwood	Chestnut oak		
Post oak	Eastern hemlock	Red maple		
Slippery elm	Black jack oak	White ash		
Redbud	White ash	Tulip poplar		
	Winged American elm	Box elder		
		Post oak		
		Redbud		
		Black jack oak		

TABLE 2.7-46

OVERSTORY AND UNDERSTORY ASSOCIATIONS ON THE ALTERNATE CLINCH RIVER TRANSMISSION ROUTE

Hardwood	Natural Pine	Pine Plantation	Cedar	Open
		OVERSTORY		
Northern Red oak	Loblolly pine	Loblolly pine	Eastern redcedar	
White Oak	Virginia pine			
Scarlet oak	Shortleaf pine			
Black oak	White pine			
Yellow oak				
Chestnut oak				
Mockernut hickory				
Black walnut				
Sycamore				
Black gum				
Sweet gum				
Red maple				
Silver maple				
White ash				
Tulip poplar				
Redbud				
Sassafrass				
		UNDERSTORY		
Eastern redcedar	Flowering dogwood	Carolina buckthorn	Virginia pine	American basswood
Red maple	Sourwood	Eastern redcedar	Shortleaf pine	Rose
Ironwood	Sweet gum	Winged sumac	Tulip poplar	Black cherry
Sassafrass	Red bud	Rose	Sycamore	Carolina buckthorn
White ash	White ash	Flowering dogwood	Black cherry	White ash
Tulip poplar	Black jack oak	Redbud	Redbud	Slippery elm
Paw paw	Post oak	Sassafrass	Flowering dogwood	Flowering dogwood
Black gum	Yellow oak	Black jack oak	Sourwood	Redbud
Black cherry	White oak	Black cherry	Red maple	
Slippery elm	Virginia pine	Smooth Sumac		
Deerberry	Loblolly pine	Yellow oak		
Mockernut hickory	Shortleaf pine	Mockernut hickory		
Smooth sumac	Eastern redcedar	Red maple		
Blueberry	Sycamore	Winged elm		
American basswood	Slippery elm			
Hackberry	Sassafrass			
White oak	Persimmons			
Post oak	Winged elm			
Northern red oak	Winged sumac			
	Red maple			
	Spicebush			
	Maple leaf viburnum			

TABLE 2.7-47

MAMMALS OBSERVED OR TRAPPED ON THE CLINCH RIVER SITE
DURING LATE WINTER AND SPRING SURVEYS (1974)

	Study Areas*											
Species	A+	B**	C+	D**	E+	F**	G+	H**	I+	J+	K**	Tx**
Raccoon						X		X				
Gray Squirrel	X	X								X		
Cottontail			X				X				X	X
Woodchuck										X		X
Chipmunk			X									
White-tail Deer	X	X	X				X			X	X	X
Gray Fox												X
Oppossum			X									
W-footed Mouse							X		X		X	
Golden Mouse							X	X	X			
Short-tail Shrew			X								X	

*See Figure 2.7-2 for location of study areas
**Live trap grid (small mammals)
+Snap trap transect (small mammals)

TABLE 2.7-48

MAMMALS OF THE CLINCH RIVER SITE[14,15,16]

*	Opossum	Didelphis marsupialis
**	Smoky shrew	Sorex fumeus
*	Southeastern shrew	Sorex longirostris
*	Least shrew	Cryptotis parva
*+	Short-tailed shrew	Blarina brevicauda
*	Eastern mole	Scalopus aquaticus
*	Little brown bat	Myotis lucifugus
**	Mississippi bat	Myotis austroriparius
**	Gray bat	Myotis grisescens
**	Keen's bat	Myotis keeni
**	Indiana bat	Myotis sodalis
**	Silver-haired bat	Lasionycteris noctivagans
**	Eastern pipistrel	Pipistrellus subflavus
**	Big brown bat	Eptesicus fuscus
*	Red bat	Lasiurus borealis
**	Hoary bat	Lasiurus cinereus
**	Evening bat	Nycticeius humeralis
**	Eastern big-eared bat	Plecotus rafinesquei
*+	Raccoon	Procyon lotor
**	Long tail weasel	Mustela frenata
*	Mink	Mustela vison
**	Spotted skunk	Spilogale putorius
*	Striped skunk	Mephitis mephitis
*	Red fox	Vulpes fulva
*	Gray fox	Urocyon cinereoargenteus
*	Bobcat	Lynx rufus
*+	Woodchuck	Marmota monax
*+	Eastern chipmunk	Tamias striatus
*+	Eastern gray squirrel	Sciurus carolinensis

(Continued)

TABLE 2.7-48 (Continued)

* Eastern fox squirrel	Sciurus niger
** Southern flying squirrel	Glaucomys volans
* Eastern harvest mouse	Reithrodontomys humulis
*+ White-footed mouse	Peromyscus leucopus
*+ Golden mouse	Peromyscus nuttalli
** Eastern woodrat	Neotoma floridana
* Rice rat	Oryzomys palustris
* Hispid cotton rat	Sigmodon hispidus
* Pine vole	Pitymys pinetorum
* Muskrat	Ondatra zibethica
* Norway rat	Rattus norvegicus
* House mouse	Mus musculus
*+ Eastern cottontail	Sylvilagus floridanus
*+ White-tailed deer	Odocoileus virginianus

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*Identified during various studies in the Oak Ridge area (14,15)

**Species which may occur on Site but have not been recorded in the general area

+Identified on Site during spring surveys

TABLE 2.7-49

ALL AVIFAUNA SPECIES OBSERVED ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Canada goose	Branta canadensis
Wood duck	Aix sponsa
Turkey vulture	Cathartes aura
Black vulture	Coragyps atratus
Red-tailed hawk	Buteo jamaicensis
Red-shouldered hawk	Buteo lineatus
Broad-winged hawk	Buteo platypterus
Sharp-shinned hawk	Accipiter striatus
Coopers hawk	Accipiter cooperii
American osprey	Pandion haliaetus
Sparrow hawk	Falco sparverius
Ruffed grouse	Bonasa umbellus
Bobwhite quail	Colinus virginianus
Great blue heron	Ardea herodias
Green heron	Butorides virescens
American coot	Fulica americana
American woodcock	Philohela minor
Common snipe	Capella gallinago
Spotted sandpiper	Actitis macularia
Mourning dove	Zenaidura macroura
Black-billed cuckoo	Coccyzus erythropthalmus
Yellow-billed cuckoo	Coccyzus americanus
Chuck-will's-widow	Caprimulgus carolinensis
Whip-poor-will	Caprimulgus vociferus
Common nighthawk	Chordeiles minor
Screech owl	Otus asio
Great horned owl	Bubo virginianus
Barred owl	Strix varia

(Continued)

TABLE 2.7-49 (Continued)

Common Name	Scientific Name
Chimney swift	Chaetura pelagica
Ruby-throated hummingbird	Archilochus colubris
Belted kingfisher	Megaceryle alcyon
Common flicker	Colaptes auratus
Pileated woodpecker	Dryocopus pileatus
Red-bellied woodpecker	Centurus carolinus
Downy woodpecker	Dendrocopos pubescens
Hairy woodpecker	Dendrocopos villosus
Yellow-bellied sapsucker	Sphyrapicus varius
Eastern kingbird	Tyrannus tyrannus
Great crested flycatcher	Myiarchus crinitus
Eastern phoebe	Sayornis phoebe
Acadian flycatcher	Empidonax virescens
Eastern wood pewee	Contopus virens
Rough-winged swallow	Stelgidopteryx ruficollis
Purple martin	Progne subis
Blue jay	Cyanocitta cristata
Crow	Corvus brachyrhynchos
Carolina chickadee	Parus carolinensis
Tufted titmouse	Parus bicolor
White-breasted nuthatch	Sitta carolinensis
Red-breasted nuthatch	Sitta canadensis
Brown creeper	Certhia familiaris
Winter wren	Troglodytes troglodytes
Carolina wren	Thryothorus ludovicianus
Mockingbird	Mimus polyglottos
Gray catbird	Dumetella carolinensis
Brown thrasher	Toxostoma rufum
Robin	Turdus migratorius

(Continued)

TABLE 2.7-49 (Continued)

Common Name	Scientific Name
Wood thrush	*Hylocichla mustelina*
Hermit thrush	*Hylocichla guttata*
Swainson's thrush	*Hylocichla ustulata*
Eastern bluebird	*Sialia sialis*
Blue-gray gnatcatcher	*Polioptila caerulea*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*Regulus calendula*
Cedar waxwing	*Bombycilla cedrorum*
Loggerhead strike	*Lanius ludovicianus*
Starling	*Sturnus vulgaris*
White-eyed vireo	*Vireo griseus*
Yellow-throated vireo	*Vireo flavifrons*
Red-eyed vireo	*Vireo olivaceus*
Black and white warbler	*Mniotilta varia*
Prothonotary warbler	*Protonotaria citrea*
Worm-eating warbler	*Helmitheros vermivorus*
Tennessee warbler	*Vermivora peregrina*
Golden winged warbler	*Vermivora chrysoptera*
Northern Parula warbler	*Parula americana*
Magnolia warbler	*Dendroica magnolia*
Black-throated green warbler	*Dendroica virens*
Blackburnian warbler	*Dendroica fusca*
Bay-breasted warbler	*Dendroica castanea*
Yellow warbler	*Dendroica petechia*
Blackpoll warbler	*Dendroica striata*
Pine warbler	*Dendroica pinus*
Prairie warbler	*Dendroica discolor*
Yellow-rumped warbler	*Dendroica coronata*
Cerulean warbler	*Dendroica cerulea*

(Continued)

TABLE 2.7-49 (Continued)

Common Name	Scientific Name
Yellow-throated warbler	Dendroica dominica
Ovenbird	Seiurus aurocapillus
Louisiana waterthrush	Seiurus motacilla
Kentucky warbler	Oporornis formosus
Yellowthroat	Geothlypis trichas
Yellow-breasted chat	Icteria virens
Hooded warbler	Wilsonia citrina
Eastern meadowlark	Sturnella magna
Red-winged blackbird	Agelaius phoeniceus
Rusty blackbird	Euphagus carolinus
Brown-headed cowbird	Molothrus ater
Common grackle	Quiscalus quiscula
Orchard oriole	Icterus spurius
Summer tanager	Piranga rubra
Scarlet tanager	Piranga olivacea
Cardinal	Richmondena cardinalis
Purple finch	Carpodacus purpureus
Rose-breasted grosbeak	Pheucticus ludovicianus
Blue grosbeak	Guiraca caerulea
Indigo bunting	Passerina cyanea
Pine siskin	Spinus pinus
American goldfinch	Spinus tristis
Red crossbill	Loxia curvirostra
Rufous-sided towhee	Pipilo erythrophthalmus
Chipping sparrow	Spizella passerina
Field sparrow	Spizella pusilla
Savannah sparrow	Passerculus sandwichensis
Swamp sparrow	Melospiza georgiana
Song sparrow	Melospiza melodia

(Continued)

TABLE 2.7-49 (Continued)

Common Name	Scientific Name
Dark-eyed junco	Junco hyemalis
Fox sparrow	Passerella iliaca
White-throated sparrow	Zonotrichia albicollis
White-crowned sparrow	Zonotrichia leucophrys

TABLE 2.7-50

AVIFAUNA OF THE OAK RIDGE RESERVATION[18]

Common Name	Scientific Name
Pied-billed grebe	Podilymbus podiceps
Canada goose	Branta canadensis
Mallard	Anas platyrhynchos
Black duck	Anas rubripes
Pintail	Anas acuta
Gadwall	Anas strepera
American widgeon	Mareca americana
Blue-winged teal	Anas discors
Green-winged teal	Anas carolinensis
Wood duck	Aix sponsa
Red head	Aythya americana
Canvasback	Aythya valisineria
Ring-necked duck	Aythya collaris
Lesser scaup	Aythya affinis
Common goldeneye	Bucephala clangula
Bufflehead	Bucephala albeola
Ruddy duck	Oxyura jamaicensis
Common merganser	Mergus merganser
Red-breasted merganser	Mergus serrator
Hooded merganser	Lophodytes cucullatus
Turkey vulture	Cathartes aura
Black vulture	Coragyps atratus
Cooper's hawk	Accipiter cooperii
Sharp-shinned hawk	Accipiter striatus
Marsh hawk	Circus cyaneus
Red-tailed hawk	Buteo jamaicensis

(Continued)

TABLE 2.7-50 (Continued)

Common Name	Scientific Name
Red-shouldered hawk	Buteo lineatus
Broad-winged hawk	Buteo platypterus
Southern bald eagle	Haliaeetus leucocephalus leucocephalus
Osprey	Pandion haliaetus
Sparrow hawk	Falco sparverius
Turkey	Meleagris gallopavo
Ruffed grouse	Bonasa umbellus
Bobwhite quail	Colinus virginianus
Common egret	Casmerodius alba
Cattle egret	Bubucus ibis
Great blue heron	Ardea herodias
Green heron	Butorides virescens
White ibis	Eudocimus albus
Common gallinule	Gallinula chloropus
American coot	Fulica americana
Killdeer	Charadrius vociferus
American woodcock	Philohela minor
Common snipe	Capella gallinago
Spotted sandpiper	Actitis macularia
Herring gull	Larus argentatus
Ring-billed gull	Larus delawarensis
Black tern	Chlidonias niger
Rock dove	Columbia livia
Mourning dove	Zenaidura macroura
Yellow-billed cuckoo	Coccyzus americanus
Screech owl	Otus asio
Great horned owl	Bubo virginianus
Chuck-will's-widow	Caprimulgus carolinensis
Whip-poor-will	Caprimulgus vociferus

(Continued)

TABLE 2.7-50 (Continued)

Common Name	Scientific Name
Common nighthawk	Chordeiles minor
Ruby-throated hummingbird	Archilochus colubris
Belted kingfisher	Megaceryle alcyon
Common flicker	Colaptes auratus
Pileated woodpecker	Dryocpus pileatus
Red-bellied woodpecker	Centurus carolinus
Hairy woodpecker	Dendrocopos villosus
Downy woodpecker	Dendrocopos pubescens
Red-headed woodpecker	Melanerpes erythrocephalus
Yellow-bellied sapsucker	Sphyrapicus varius
Eastern kingbird	Tyrannus tyrannus
Great crested flycatcher	Myiarchus crinitus
Eastern phoebe	Sayornis phoebe
Acadian flycatcher	Empidonax virescens
Least flycatcher	Empidonax minimus
Eastern wood pewee	Contopus virens
Horned lark	Eremophila alpestris
Bank swallow	Riparia riparia
Rough-winged swallow	Stelgidepteryx ruficollis
Barn swallow	Hirundo rustica
Purple martin	Progne subis
Blue jay	Cyanocitta cristata
Crow	Corvus brachyrhynchos
Carolina chickadee	Parus carolinensis
Tufted titmouse	Parus bicolor
White-breasted nuthatch	Sitta carolinensis
House wren	Troglodytes aedon
Bewick's wren	Thryomanes bewickii

(Continued)

TABLE 2.7-50 (Continued)

Common Name	Scientific Name
Carolina wren	Thryothorus ludovicianus
Mockingbird	Mimus polyglottos
Gray catbird	Dumetella carolinensis
Brown thrasher	Toxostoma rufum
Robin	Turdus migratorius
Wood thrush	Hylocichla mustelina
Eastern bluebird	Sialia sialis
Blue-grapy gnatcatcher	Polioptila caerulea
Golden-crowned kinglet	Regulus satrapa
Rudy-crowned kinglet	Regulus calendula
Cedar waxwing	Bombycilla cedrorum
Loggerhead shrike	Lanius ludovicianus
Starling	Sturnus vulgaris
White-eyed vireo	Vireo griseus
Yellow-throated vireo	Vireo flavifrons
Red-eyed vireo	Vireo olivaceus
Black-and-white warbler	Mniotilta varia
Prothonotary warbler	Protonotaria citrea
Worm-eating warbler	Helmitheros vermivorus
Northern parula warbler	Parula americana
Yellow warbler	Dendroica petechia
Cerulean warbler	Dendroica cerulea
Yellow-throated warbler	Dendroica cominica
Pine warbler	Dendroica pinus
Prairie warbler	Dendroica discolor
Ovenbird	Seiurus aurocapillus
Louisiana waterthrush	Seiurus motacilla
Kentucky warbler	Oporornis formosus

(Continued)

TABLE 2.7-50 (Continued)

Common Name	Scientific Name
Yellowthroat	Geothlypis trichas
Yellow-breasted chat	Icteria virens
Hooded warbler	Wilsonia citrina
American redstart	Setophaga ruticilla
English sparrow	Passer domesticus
Eastern meadowlark	Sturnella magna
Red-winged blackbird	Agelaius phoeniceus
Brown-headed cowbird	Molothrus ater
Common grackle	Quiscalus quiscula
Orchard oriole	Icterus spurius
Summer tanager	Piranga rubra
Scarlet tanager	Piranga olivacea
Cardinal	Richmondena cardinalis
Rose-breasted grosbeak	Pheucticus lodovicianus
Blue grosbeak	Guiraca caerulea
Indigo bunting	Passerina cyanea
Purple finch	Carpodacus purpureus
Pine siskin	Spinus pinus
American goldfinch	Spinus tristis
Red crossbill	Loxia curvirostra
Rufous-sided towhee	Pipilo erythrophthalmus
Grasshopper sparrow	Ammodramus savannarum
Henslow's sparrow	Passerherbulus henslowii
Bachman's sparrow	Aimophila aestivalis
Chipping sparrow	Spizella passerina
Field sparrow	Spizella pusilla
White-throated sparrow	Zonotrichia albicollis
Song sparrow	Melospiza melodia
Dark-eyed junco	Junco hyemalis

TABLE 2.7-51

AVIFAUNA SPECIES OBSERVED IN HARDWOOD COMMUNITIES ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Turkey vulture	Cathartes aura
Black vulture	Coragyps atratus
Red-tailed hawk	Buteo jamaicensis
Red-shouldered hawk	Buteo lineatus
Broad-winged hawk	Buteo platypterus
Coopers hawk	Accipiter cooperii
Ruffed grouse	Bonasa umbellus
Chuck-will's widow	Caprimulgus carolinensis
Whip-poor-will	Caprimulgus vociferus
Screech owl	Otus asio
Great horned owl	Bubo virginianus
Barred owl	Strix varia
Common nighthawk	Chordeiles minor
Pileated woodpecker	Drycopus pileatus
Red-bellied woodpecker	Centurus carolinus
Downy woodpecker	Dendrocopos pubescens
Hairy woodpecker	Dendrocopos villosus
Yellow-bellied sapsucker	Sphyrapicus varius
Great crested flycatcher	Myiarchus crinitus
Eastern phoebe	Sayornis phoebe
Acadian flycatcher	Empidonax virescens
Eastern wood pewee	Contopus virens
Blue jay	Cyanocitta cristata
Crow	Corvus brachyrhynchos
Carolina chickadee	Parus carolinensis
Tufted titmouse	Parus bicolor
White-breasted nuthatch	Sitta carolinensis
Red-breasted nuthatch	Sitta canadensis

(Continued)

TABLE 2.7-51 (Continued)

Common Name	Scientific Name
Brown creeper	*Certhia familiaris*
Winter wren	*Troglodytes troglodytes*
Carolina wren	*Thryothorus ludovicianus*
Brown thrasher	*Toxostoma rufum*
Wood thrush	*Hylocichla mustelina*
Hermit thrush	*Hylocichla guttata*
Swainson's thrush	*Hylocichla ustolata*
Blue-gray gnatcatcher	*Polioptila caerulea*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*Regulus calendula*
Yellow-throated vireo	*Vireo flavifrons*
Red-eyed vireo	*Vireo olivaceus*
Black-and-white warbler	*Mniotilta varia*
Worm-eating warbler	*Helmitheros vermivorus*
Tennessee warbler	*Vermivora peregrina*
Northern parula warbler	*Parula americana*
Magnolia warbler	*Dendroica magnolia*
Black-throated green warbler	*Dendroica virens*
Blackburnian warbler	*Dendroica fusca*
Bay-breasted warbler	*Dendroica castanea*
Blackpoll warbler	*Dendroica striata*
Yellow-rumped warbler	*Dendroica coronata*
Cerulean warbler	*Dendroica cerulea*
Yellow-throated warbler	*Dendroica dominica*
Ovenbird	*Seiurus aurocapillus*
Kentucky warbler	*Oporornis formosus*
Hooded warbler	*Wilsonia citrina*
Summer tanager	*Piranga rubra*
Scarlet tanager	*Piranga olivacea*

(Continued)

TABLE 2.7-51 (Continued)

Common Name	Scientific Name
Purple finch	Carpodacus purpureus
Rose-breasted grosbeak	Pheucticus ludovicianus
Pine siskin	Spinus pinus
Red crossbill	Loxia curvirostra
Rufous-sided towhee	Pipilo erythrophthalmus
Dark-eyed junco	Junco hyemalis
White-throated sparrow	Zonotrichia albicollis

TABLE 2.7-52

AVIFAUNA SPECIES OBSERVED ALONG BORDERS OF FIELDS, TRANSMISSION LINES AND FOREST COMMUNITIES ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Turkey vulture	Cathartes aura
Black vulture	Coragyps atratus
Red-tailed hawk	Buteo jamaicensis
Red-shouldered hawk	Buteo lineatus
Broad-winged hawk	Buteo platypterus
Sharp-shinned hawk	Accipiter striatus
Coopers hawk	Accipiter cooperii
Sparrow hawk	Falco sparverius
Ruffed grouse	Bonasa umbellus
Bobwhite quail	Colinus virginianus
American woodcock	Philohela minor
Mourning dove	Zenaidura macroura
Black-billed cuckoo	Coccyzus erythropthalmus
Yellow-billed cuckoo	Coccyzus americanus
Screech owl	Otus asio
Barred owl	Strix varia
Common nighthawk	Chordeiles minor
Chimney swift	Chaetura pelagica
Common flicker	Colaptes auratus
Purple martin	Progne subis
Blue jay	Cyanocitta cristata
Crow	Corvus brachyrhynchos
Carolina chickadee	Parus carolinensis
Tufted titmouse	Parus bicolor
Winter wren	Troglodytes troglodytes
Carolina wren	Thryothorus ludovicianus
Mockingbird	Mimus polyglottos

(Continued)

TABLE 2.7-52 (Continued)

Common Name	Scientific Name
Gray catbird	Dumetella carolinensis
Robin	Turdus migratorius
Eastern bluebird	Sialia sialis
Blue-gray gnatcatcher	Polioptila caerulea
Golden-crowned kinglet	Regulus satrapa
Ruby-crowned kinglet	Regulus calendula
Cedar waxwing	Bombycilla cedrorum
Loggerhead shrike	Lanius ludovicianus
Golden-winged warbler	Vermivora chrysoptera
Magnolia warbler	Dendroica magnolia
Blackburnian warbler	Dendroica fusca
Yellow warbler	Dendroica petechia
Yellow-rumped warbler	Dendroica coronata
Pine warbler	Dendroica pinus
Prairie warbler	Dendroica discolor
Orchard oriole	Icterus spurius
Summer tanager	Piranga rubra
Scarlet tanager	Piranga olivacea
Cardinal	Richmondena cardinalis
Rose-breasted grosbeak	Pheucticus ludovicianus
Blue grosbeak	Guiraca caerulea
Indigo bunting	Passerina cyanea
Pine siskin	Spinus pinus
American goldfinch	Spinus tristis
Rufous-sided towhee	Pipilo erthrophthalmus
Field sparrow	Spizella pusilla
Savannah sparrow	Passerculus sandwichensis
Song sparrow	Melospiza melodia
Dark-eyed junco	Junco hyemalis

(Continued)

TABLE 2.7-52 (Continued)

Common Name	Scientific Name
Fox sparrow	Passerella iliaca
White-throated sparrow	Zonotrichia albicollis
White-crowned sparrow	Zonotrichia leucophrys

TABLE 2.7-53

AVIFAUNA SPECIES OBSERVED IN NATURAL PINE COMMUNITIES G AND H*
AND IN OPEN HABITATS ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Turkey vulture	*Cathartes aura*
Black vulture	*Coragyps atratus*
Red-shouldered hawk	*Buteo lineatus*
Broad-winged hawk	*Buteo platypterus*
Sharp-shinned hawk	*Accipiter striatus*
Sparrow hawk	*Falco sparverius*
Bobwhite quail	*Colinus virginianus*
American woodcock	*Philohela minor*
Mourning dove	*Zenaidura macroura*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Ruby-throated hummingbird	*Archilochus colubris*
Common flicker	*Colaptes auratus*
Eastern kingbird	*Tyrannus tyrannus*
Purple martin	*Progne subis*
Crow	*Corvus brachyrhynchos*
Carolina wren	*Thryothorus ludovicianus*
Gray catbird	*Dumetella carolinensis*
Brown thrasher	*Toxostoma rufum*
Robin	*Turdus migratorius*
Eastern bluebird	*Sialia sialis*
Cedar waxwing	*Bombycilla cedrorum*
Loggerhead strike	*Lanius ludovicianus*
Starling	*Sturnus vulgaris*
White-eyed vireo	*Vireo griseus*
Yellow warbler	*Dendroica petechia*

(Continued)

TABLE 2.7-53 (Continued)

Common Name	Scientific Name
Yellow-rumped warbler	Dendroica coronata
Yellowthroat	Geothlypis trichas
Yellow-breasted chat	Icteria virens
Eastern meadowlark	Sturnella magna
Red-winged blackbird	Agelaius phoeniceus
Brown-headed cowbird	Molothrus ater
Common grackle	Quiscalus quiscula
Indigo bunting	Passerina cyanea
American goldfinch	Spinus tristis
Rufous-sided towhee	Pipilo erythrophthalmus
Chipping sparrow	Spizella passerina
Field sparrow	Spizella pusilla
Savannah sparrow	Passerculus sandwichensis
Song sparrow	Melospiza melodia
White-crowned sparrow	Zonotrichia leucophrys

*See Figure 2.7-2

TABLE 2.7-54

AVIFAUNA SPECIES OBSERVED NEAR AQUATIC COMMUNITIES ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Turkey vulture	Cathartes aura
Black vulture	Coragyps atratus
Canada goose	Branta canadensis
Wood duck	Aix sponsa
Broadwinged hawk	Buteo platypterus
Osprey	Pandion haliaetus
Great blue heron	Ardea herodias
Green heron	Butorides virescens
American coot	Fulica americana
Common snipe	Capella gallinago
Spotted sandpiper	Actitis macularia
Belted kingfisher	Megaceryle alcyon
Eastern kingbird	Tyrannus tyrannus
Rough-winged swallow	Stelgidopteryx ruficollis
Carolina wren	Thryothorus ludovicianus
Gray catbird	Dumetella carolinensis
White-eyed vireo	Vireo griseus
Prothonotary warbler	Protonotaria citrea
Yellow warbler	Dendroica petechia
Yellow-rumped warbler	Dendroica coronata
Louisianna waterthrush	Seriurus motacilla
Yellowthroat	Geothlypis trichas
Yellow-breasted chat	Icteria virens
Red-winged blackbird	Agelaius phoeniceus
Rusty blackbird	Euphagus carolinus
Common grackle	Quiscalus quiscula
Cardinal	Richmondena cardinalis
Indigo bunting	Passerina cyanea
Rufous-sided towhee	Pipilo erythrophthalmus
Swamp sparrow	Melospiza georgiana

TABLE 2.7-55

AVIFAUNA SPECIES OBSERVED IN CONIFEROUS COMMUNITIES B, C, E AND I*
ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Turkey vulture	*Catharces aura*
Black vulture	*Coragyps atraths*
Downy woodpecker	*Dendrocopos pubescens*
Blue jay	*Cyanocitta cristata*
Caroline chickadee	*Parus carolinensis*
White-breasted nuthatch	*Sitta carolinensis*
Golden-crowned kinglet	*Regulus satrapa*
Rudy-crowned kinglet	*Regulus calendula*
Northern parula warbler	*Parula americana*
Magnolia warbler	*Dendroica magnolia*
Pine warbler	*Dendroica pinus*
Prairie warbler	*Dendroica discolor*
Yellow-rumped warbler	*Dendroica coronata*
Yellow-breasted chat	*Icteria virens*
Pine siskin	*Spinus pinus*
Red crossbill	*Loxia curvirostra*
Dark-eyed junco	*Junco hyemalis*
Fox sparrow	*Passerella iliaca*
White-throated sparrow	*Zonotrichia albicollis*

*See Figure 2.7-2

TABLE 2.7-56

THE MOST COMMONLY OBSERVED AVIFAUNA SPECIES OBSERVED ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Indigo bunting	Passerina cyanea
Prairie warbler	Dendroica discolor
White-eyed vireo	Vireo griseus
Red-eyed vireo	Vireo olivaceus
Cardinal	Richmondena cardinalis
Carolina wren	Thryothorus lodovicianus
Field sparrow	Spizella pusilla
Starling	Sturnus vulgaris
Common grackle	Quiscalus quiscula
Red-winged blackbird	Agelaius phoeniceus
Blue jay	Cyanocitta cristata
Blue-gray gnatcatcher	Polioptila caerulea

TABLE 2.7-57

RELATIVE ABUNDANCE OF HERPETOFAUNA SPECIES OBSERVED ON THE CLINCH RIVER SITE

Common Name	Scientific Name
Slimy salamander	*Plethodon glutinosus glutinosus*
Northern spring peeper	*Hyla crucifer crucifer*
Bullfrog (1)	*Rana catesbeiana*
Green frog (10 +)	*Rana clamitans melanota*
Pickerel frog (1)	*Rana palustris*
Common snapping turtle (1)	*Chelydra serpentina serpentina*
Eastern box turtle (3)	*Terrapene carolina carolina*
Northern fence lizard (12 +)	*Sceloporous hyacinthinus*
Northern red-bellied snake (1)	*Storeria occipitomaculata occipitomaculata*
Eastern worm snake (1)	*Carphophis amoenus amoenus*
Black racer (2)	*Coluber constrictor*
Corn snake (1)	*Elaphe guttata guttata*
Rat snake (1)	*Elaphe obsoleta*

TABLE 2.7-58

HERPETOFAUNA SPECIES OBSERVED ON THE OAK RIDGE RESERVATION[24]

Common Name	Scientific Name
Spotted salamander	Ambystoma maculatum
Eastern red-spotted newt	Diemictylus viridescens viridescens
Dusky salamander	Desmognathus fuscus
Slimy salamander	Plethodon glutinosus glutinosus
Northern red salamander	Pseudotriton ruber ruber
Two-lined salamander	Eurycea bislineata
Cave salamander	Eurycea lucifuga
Eastern spadefoot toad	Scaphiopus holbrooki holbrooki
American toad	Bufo americanus americanus
Fowler's toad	Bufo woodhousei fowleri
Northern cricket frog	Acris crepitans crepitans
Northern spring peeper	Hyla crucifer crucifer
Eastern gray treefrog	Hyla versicolor versicolor
Chorus frog	Pseudacris triseriata
Eastern narrow-mouthed toad	Gastrophyryne carolinensis carolinensis
Bullfrog	Rana catasbeiana
Green frog	Rana clamitans melanota
Leopard frog	Rana pipiens
Pickerel frog	Rana palustris
Common snapping turtle	Chelydra serpentina serpentina
Stinkpot	Sternothaerus adoratus
Striped-necked musk turtle	Sternothaerus minor peltifer
Eastern box turtle	Terrapene carolina carolina
Map turtle	Graptemys geographica
Ouachita map turtle	Graptemys pseudogeographica ouachitensis
Painted turtle	Chyrsemys picta
Slider	Pseudemys concinna hieroglyphica

(Continued)

TABLE 2.7-58 (Continued)

Common Name	Scientific Name
Pond slider	Pseudemys scripta
Eastern spiny softshell turtle	Trionyx spinifer spinifer
Northern fence lizard	Sceloporous hyacinthinus
Six-lined race runner	Cnemidophorus sexlineatus
Ground skink	Lygosoma laterale
Five-lined skink	Eumeces fasciatus
Broad-headed skink	Eumeces laticeps
Queen snake	Natrix septemvittata septemvittata
Water snake	Natrix sipedon
Brown snake	Storeria dekayi
Northern red-bellied snake	Storeria occipitomaculata occipitomaculata
Eastern garter snake	Thamnophis sirtalis sirtalis
Eastern earth snake	Virginia valeriae valeriae
Northern ringneck snake	Diadophis punctatus edwarsi
Eastern work snake	Carphophis amoenus amoenus
Racer	Coluber constrictor
Rough green snake	Opheodrys aestivus
Corn snake	Elaphe guttata guttata
Rat snake	Elaphe obsoleta
Mole snake	Lampropeltis calligaster rhombomaculata
Black kingsnake	Lampropeltis getulus niger
Eastern milksnake	Lampropeltis dioliata triangulum
Scarlet snake	Cemophora coccinea
Northern copperhead	Ancistrodon contortrix mokeson

TABLE 2.7-59

FOREST INVERTEBRATE FAUNA IDENTIFIED ON THE OAK RIDGE RESERVATION

Annelida - Segmented worms

Oligochaeta - Freshwater and terrestrial segmented worms

Lumbricidae

Allolobophora terrestris

Bimastus tenuis

Dendrobaena octaedra

Diplocardia udei

Lumbricus rutellus

Lumbricus terrestris

Octolasium cyaneum

Octolasium lacteum

Arthropoda - Crustaceans, spiders and insects

Diplopoda - Millipedes

Polydesmida

Xysto desmidae

Apheloria montana

Brachoria initialis

Gyalostethus monticolens

Polydesmidae

Dixidesmus erasus

Scytonotus granulatus

Euryuridae

Euryurus leachii fraternus

Cambalida

Cambalidae

Cambala annulata

(Continued)

TABLE 2.7-59 (Continued)

Platydesmida
  Andrognathidae
    Brachycybe lecontei
    Brachycybe petasata
Julida
  Parajulidae
    Ptyoiulus impressus
Chilopoda - Centipedes
  Lithobiomorpha
    Lithobiidae
  Scolopendromorpha
    Cryptopidae
      Otocryptops nigridus
      Otocryptops sexpinosus
      Theatops posticus
  Geophilomorpha
    Geophilidae
      Linotaenia bidens (Wood)
Crustacea - Crustaceans
  Isopoda
    Ligiidae
      Ligidium sp.
Arachnida - Spiders, scorpions and mites
  Acarina - Mites and ticks
    Prostigmata
      Bdellidae
      Trombidiidae
      Tydeidae

(Continued)

TABLE 2.7-59 (Continued)

Mesostigmata	
Parasitidae	
Uropodidae	
	Uropoda sp.
Rhodacaridae	
Cryptostigmata	
Orbatidae	
Astigmata	
Tyroglyphidae	
Araneida - Spiders	
Antrodiaetidae	
	Antrodiaetus shoemakeri (Petrunkovitch)
Ctenizidae	
	Pachylomerides audouini (Lucas)
Agelenidae	
	Agelenopsis oklahoma (Gertsch)
	Agroeca pratensis Emerton
	Cicurina arcuata Keyserling
	Coras taugynus Keyserling
	Wadotes hybridus (Emerton)
Anyphaenidae	
	Anyphaenella saltabunda (Hentz)
Clubionidae	
	Castianeira alata Muma
	Clubiona obesa Hentz
	Phrurotimpus alarius
Ctenidae	
	Anahita animosa (Alkekenaer)
Dictynidae	
	Lathys masculina Gertsch

(Continued)

Gnaphosidae

- Drassyllus virginianus Chamberlin
- Gnaphosa fontinalis Keyserling
- Litopyllus rupicolens Chamberlin
- Rachodrassus echinus Chamberlin
- Zelotes subterraneus (Koch)

Hahniidae

- Hahnia cinerea Emerton

Linyphaeidae

- Lepthyphantes sabulosa (Keyserling)
- Linyphia maculata Emerton
- Meioneta angulata (Emerton)

Lycosidae

- Lycosa avara (Keyserling)
- Lycoasa gulosa Walckenaer
- Lycosa punctulata Hentz
- Schizocosa sp.

Salticidae

- Habrocestum pervulum (Banks)
- Paraphidippus marginatus (Walckenaer)
- Thiodina puerpera (Hentz)

Thomisidae

- Xysticus auctificus Keyserling
- Xysticus elenans Keyserling
- Xysticus fraternus Banks
- Misumenops sp.

Araneidae

- Neoscona sp.

Micryphantidae

(Continued)

Pisauridae

Pisaurina sp.

Theridiidae

Spintharus sp.

Insecta - Insects

Thysanura - Bristletails

Machilidae

Machilis sp.

Collembola - Springtails

Poduridae

Hypogastrura (c.) cf. *armata* Nicolet

Hypogastrura (H.) sp. a.

Hypogastrura (H.) sp. b.

Morulina callowayia Ray

Tullbergia cf. *krausbaueri* Borner, 1901

Onychiurus cf. *cocklei* Folsom, 1908

Onychiurus cf. *millsi* Chamberlain, 1943

Onychiurus cf. *ramosus* Folsom, 1917

Onychiurus fimetarius group

Odontella cf. *scabra* Stach, 1946

Odontella cf. *pseudolamellifera* Stach, 1949

Pseudachorutes subcrassoides Mills, 1934

Micranurida furcifera Mills, 1934

Entomobryidae

Lepidocyrtus sp.

Sinella sp.

Pseudosinella sp. nr. *Lepidocyrtus*

Isotoma olivacea-violacea group

Proisotoma sp.

Folsomia cf. *elongata*

(Continued)

TABLE 2.7-59 (Continued)

		Folsomia fimetaria
		Folsomia cf. sensibilis
		Folsomides pervus
		Isotomiella minor
		Tomocerus cf. lamelliferus
	Sminthuridae	
		Dicyrtominae (juv.)
		Sminthurinae
		Sminthurinus cf. elegans
Orthoptera - Cockroaches and grasshoppers		
	Tetrigidae	
	Acrididae	
		Melanoplus mexicana
	Gryllacrididae	
		Ceuthophilus gracilipes
	Gryllidae	
		Gryllus vernalis
		Pteronemobius maculatus
		Pteronemobius (nymph)
		Oecanthus quandripunctatus
	Blattidae	
		Parcoblatta sp.
		Cryptocercus punctulatus Scudder
	Tettigoniidae	
		Atlanticus gibbosus Scudder
Isoptera - Termites		
	Rhinotermitidae	
Psocoptera - Booklice and barklice		
	Psocidae	

(Continued)

TABLE 2.7-59 (Continued)

Hemiptera - True bugs
- Miridae
- Reduviidae
- Lygaeidae
- Coreidae
  - _Acanthocephala femorata_
- Corimelaenidae

Homoptera - Leafhoppers and aphids
- Cicadidae
  - _Ticicen_ sp.
- Membracidae
  - _Membracidae_ (immature)
- Cercopidae
- Cicadellidae (nymph)
- Fulgoridae
- Aphididae

Neuroptera - Dobsonflies and lacewings
- Myrmeleontidae (larvae)
- Chrysopidae
  - _Chrysopa_ sp. (larvae)

Coleopetra - Beetles
- Anobiidae
- Cicindelidae
  - _Cicindela sexguttata_
  - _Cicindela unipunctata_
- Carabidae (larvae)
  - Cychrini (small, unidentified)
    - _Maronetus_
    - undescribed species of _Maronetus_
    - _Sphaeroderus stenostomus_ Web.

(Continued)

TABLE 2.7-59 (Continued)

	Scaphinotus (s.str.) unicolor (Oliv.) heros Harr.
	Scaphinotus (Steniridia) andrewsii (Harr.) germari Chd.
Carabini	
	Calosoma
Dryptini	
	Galerita (larvae)
	Galerita janus
Scaritini	
	Pasimachus elongatus LeC.
	Pasimachus depressus
Pterostichini	
	Trigonognatha coracina Say
	Evarthrus (Eumolops) sodalis LeC.
	Evarthrus (s.str.) americanus Dej.
	Pterostichus (Gastrostictus) obscurus Say
Licinini	
	Dicaelus (Paradicaelus) furvus furvus Dej. X f. carinatus Dej.
	Dicaelus (P.) dilatatus sinuatus Ball
Harpalini	
	Harpalus (Pseudophonus) compar LeC.
Chlaeniini	
	Chlaenius sp.
	Chlaenius (Anomoglossus) emarginatus Say
Agonini	
	Olisthopus parmatus
Histeridae	
	Hololepta quadridentata (Fabricius)
Silphidae (larvae)	
	Silpha noveboracensis

(Continued)

TABLE 2.7-59 (Continued)

Staphylinidae (larvae)

Staphylinus badines

Pselaphidae

Batrisodes globosus

Cantharidae (larvae)

Lampyridae (larvae)

Photinus scintillans

Dermestidae (larvae)

Elateridae (larvae)

Aeolus melillus (larvae)

Agriotes oblongus

Alatus ocultatus (larvae)

Ctenicera sp.

Melanotus castanopes

Cucujidae

Phalacridae

Nitidulidae

Lycidae (larvae)

Coccinellidae (larvae)

Colydiidae

Meloidae

Mordellidae

Anaspis sp.

Tenebrionidae (larvae)

Melandryidae

Bostrichidae

Geotrupidae

Trox sp.

Scarabaeidae

Onthophagus sp.

(Continued)

TABLE 2.7-59 (Continued)

Cerambycidae

Dorcaschema nigrum

Chrysomelidae

Halticinae

Curculionidae

Odontopus calceatus

Ptilodactylidae (larvae)

Melolonthidae

Serica sp.

Lepidoptera (larvae) - Moths and butterflies

Arctiidae (larvae)

Citheroniidae (larvae)

Geometridae (larvae)

Noctuidae (larvae)

Diptera - Flies

Muscidae

Tipulidae

Chironomidae

Ceratopogonidae

Asilidae

Dolichopodidae

Anthomyiidae

Empididae

Phoridae

Pipunculidae

Syrphidae (larvae)

Stratiomyidae (larvae)

Culicidae

Ephydridae

(Continued)

TABLE 2.7-59 (Continued)

Bibionidae (larvae)
Mycetophilidae
Sciaridae
Bradysia tritiei (Coquillett)
Sciomyzidae
Tachinidae
Otitidae
Hymenoptera - Ants, wasps and bees
Braconidae
Agathis sp.
Ichneumonidae
Halictidae (larvae)
Vespidae
Chalcididae
Mutillidae
Pompilidae
Scoliidae
Tiphiidae
Formicidae
Prenoletis imparis
Myrmecina americana
Camponotus pennsylvanicus
Apidae
Apis mellifera

TABLE 2.7-60

SURVEY OF BEEF CATTLE AND DAIRY COWS IN AN AREA WITHIN 10 MILES OF THE CRBRP SITE

Beef Cattle

Distance From Site (miles)	Sector N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	0	0	0	0	9	0	0	0	0	44	0	0	0	0	0	0
2	0	0	0	0	0	0	0	16	10	18	0	0	0	4	0	0
3	0	0	0	0	0	38	4	0	3	0	8	23	5	0	0	0
4	0	0	0	0	0	0	4	3	8	7	46	25	49	7	0	0
5	0	0	0	0	0	0	0	0	0	20	20	0	22	0	26	56
10	171	75	0	0	0	43	14	0	33	3	0	10	0	17	17	0

Dairy Cattle

Distance From Site (miles)	Sector N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	27	0	0	0	1	0	0
3	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
4	0	0	0	0	0	0	1	0	0	0	0	0	0	27	0	0
5	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0